OVEC/IKEC

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November 17, 2020

Submitted Electronically via Email

Mr. Andrew R. Wheeler, EPA Administrator
Environmental Protection Agency
1200 Pennsylvania Avenue, N.W.
Mail Code 5304-P
Washington, DC 20460

Re: Indiana-Kentucky Electric Corporation
Clifty Creek Power Station Alternative Closure Demonstration
Amendment 1

Dear Administrator Wheeler:

The Indiana-Kentucky Electric Corporation (IKEC) hereby submits an amended request to the U.S. Environmental Protection Agency (EPA) for approval for a site-specific alternative deadline to initiate closure pursuant to 40 C.F.R. § 257.103(f)(1) for the two CCR surface impoundments (West Boiler Slag Pond and the Landfill Runoff Collection Pond) located at the Clifty Creek Power Station near Madison, Indiana. IKEC is requesting an extension pursuant to 40 C.F.R. § 257.103(f)(1) to allow the impoundments to continue to receive CCR and non-CCR waste streams after April 11, 2021, in order to retrofit the facility operations sequentially and in a holistic manner to comply with both CCR regulatory requirements as well as new Steam Electric Effluent Limitation Guidelines (ELG) requirements at 40 CFR 423 (final rule published October 13, 2020), applicable to the ash transport water used to sluice boiler slag to the West Boiler Slag Pond.

Our original submittal was filed electronically on October 15, 2020, and this amended demonstration package includes additional descriptions, clarifications and details we shared with USEPA staff during an October 29, 2020, conference call reviewing our initial demonstration submittal.

In addition to securing applicable environmental permits for construction and system modifications, the West Boiler Slag Pond (WBSP) and Landfill Runoff Collection Pond (LRCP) modifications include the following activities:

- WBSP activities:
  - Construction of a new concrete settling tank for boiler slag material within the WBSP footprint,

- Re-routing the boiler slag and mill reject sluice flows currently entering the unlined surface impoundment to the new concrete settling tank,
- Installation of piping and water treatment for the establishment of a high recycle rate boiler slag ash transport water system compliant with new ELG requirements,
- Repurposing of a portion of the unlined WBSP via construction of a new, lined low-volume wastewater treatment system (LVWTS) for treatment of non-CCR wastewater generated at the facility,
- Rerouting of the non-CCR waste streams to the LVWTS once it is constructed, and
- Initiation of closure activities for the balance of the unlined WBSP footprint.

- LRCP activities:
  - Construction of new stormwater controls to reroute stormwater from off-site sources away from plant property and around the west side of the LRCP to a new stormwater outfall,
  - Construction of a new landfill runoff/leachate management system, and
  - Initiation of closure of the balance of the LRCP.

Enclosed is a demonstration prepared by Burns & McDonnell that addresses all of the criteria in 40 C.F.R. § 257.103(f)(1)(i)-(iii) and contains the documentation required by 40 C.F.R. § 257.103(f)(1)(iv). As allowed by the agency, in lieu of hard copies of these documents, electronic files were submitted to Kirsten Hillyer, Frank Behan, and Richard Huggins via email.

If you have any questions regarding this submittal, please contact either myself at (740) 289-7299 or mbrown@ovec.com or Gabriel Coriell at either (740) 289-7267 or gcoriell@ovec.com.

Sincerely,

J. Michael Brown

J. Michael Brown
Environmental, Safety & Health Director
Ohio Valley Electric Corporation/
Indiana-Kentucky Electric Corporation

JMB:klr

Attachments

cc: Kirsten Hillyer – USEPA
Frank Behan – USEPA
Richard Huggins - USEPA

Clifty Creek Station CCR Surface Impoundment Demonstration for a Site-Specific Alternative to Initiation of Closure Deadline

Indiana-Kentucky Electric Corporation
Clifty Creek Station
Coal Combustion Residual Rule Compliance

Revision 1
November 17, 2020

Clifty Creek Station CCR Surface Impoundment Demonstration for a Site-Specific Alternative to Initiation of Closure Deadline

Prepared for

Indiana-Kentucky Electric Corporation
Clifty Creek Station
Coal Combustion Residual Rule Compliance
Madison, Indiana

Revision 1
November 17, 2020

Prepared by

Burns & McDonnell Engineering Company, Inc.
Kansas City, Missouri

INDEX AND CERTIFICATION

Indiana-Kentucky Electric Corporation
Clifty Creek Station
CCR Surface Impoundment Demonstration for a Site-Specific Alternative to Initiation of Closure Deadline

Report Index

Certification

I hereby certify, as a Professional Engineer in the State of Indiana, that the information in this document was assembled under my direct supervisory control. This report is not intended or represented to be suitable for reuse by the Indiana-Kentucky Electric Corporation or others without specific verification or adaptation by the Engineer.

RANDELL L. SEDLACEK
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STATE OF
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11/17/20

Randell L Sedlacek

Randell L Sedlacek, P.E. (IN PE11400552)

Date: November 17, 2020

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LIST OF ABBREVIATIONS

Abbreviation	**Term/Phrase/Name**
ACM	Assessment of Corrective Measures
ASD	Alternate Source Demonstration
BMcD	Burns & McDonnell
BSHS	Boiler slag handling system
CCR	Coal Combustion Residual
CFR	Code of Federal Regulations
ELGs	Effluent Limitations Guidelines and Standards for the Steam Electric Power Generating Point Source Category
EPA	Environmental Protection Agency
EPC	Engineer-Procure-Construct
FEED	Front-end engineering design
FGD	Flue Gas Desulfurization
GPM	Gallons Per Minute
GWPS	Groundwater Protection Standards
IDEM	Indiana Department of Environmental Management
IKEC	Indiana-Kentucky Electric Corporation (Owner)
IDNR	Indiana Department of Natural Resources
LRCP	Landfill Runoff Collection Pond
LVWTS	Low Volume Wastewater Treatment System
MGD	Million gallons per day
MW	Megawatt
NPDES	National Pollutant Discharge Elimination System

Abbreviation	Term/Phrase/Name
OVEC	Ohio Valley Electric Corporation (Owner)
PDC	Power Distribution Center
PDR	Project Definition Report
PSD	Prevention of Significant Deterioration
POTW	Publicly Owned Treatment Works
RCRA	Resource Conservation and Recovery Act
RWS	Indiana Restricted Waste Site
TDS	Total Dissolved Solids
U.S.C.	United States Code
WBSP	West Boiler Slag Pond

EXECUTIVE SUMMARY

The Indiana-Kentucky Electric Corporation (IKEC) is submitting this Demonstration to the U.S. Environmental Protection Agency (EPA) in order to obtain approval of an alternative site-specific date to initiate closure of the West Boiler Slag Pond (WBSP) and the Landfill Runoff Collection Pond (LRCP), both of which are located at IKEC's Clifty Creek Station in Madison, Indiana. Specifically, IKEC requests EPA establish the alternative deadline of December 5, 2022, for the Clifty Creek Station to cease all waste flows to both the WBSP and initiate closure of this coal combustion residual (CCR) unit. In addition, IKEC requests approval of an alternative deadline of April 25, 2023, to cease all waste flows and initiate closure of the LRCP. The WBSP has an approximate surface area of 75 acres and receives boiler slag sluice flows from Units 1-6, as well as the majority of the non-CCR wastestreams generated from the operation of the plant. The LRCP has an approximate surface area of 40 acres and receives stormwater from the contributing watershed, much of which is not owned by IKEC, as well as from the facility's onsite CCR landfill.

IKEC began evaluating CCR compliance options in April 2015 with the assistance of Stantec Inc. (Stantec). In 2020, IKEC hired BMcD to prepare a project definition report (PDR), which covered the scope to install a concrete settling tank within the footprint of the existing WBSP to handle boiler slag material and eliminate the discharge of bottom ash transport water as required by the Steam Electric Effluent Limitation Guidelines (ELGs) at 40 CFR 423 (85 Fed. Reg. 64,650 (October 13, 2020).

The following primary remaining activities have been identified that must be completed before IKEC can cease all CCR and non-CCR wastestreams to the CCR surface impoundments:

- WBSP activities:
    - Secure applicable environmental permits or permit modifications from the Indiana Department of Environmental Management (IDEM) and the Indiana Department of Natural Resources (IDNR)
    - Construct new concrete settling tank within the WBSP footprint to receive the boiler slag material
    - Reroute boiler slag and mill reject sluice flows to the new concrete settling tank and establish a high recycle rate system
    - Construct a new, lined low-volume wastewater treatment system (LVWTS) within the WBSP footprint for treatment of non-CCR wastewater generated at the facility
    - Reroute non-CCR wastestreams to the LVWTS

- LRCP activities:
  - Secure applicable environmental permits or permit modifications from IDEM and IDNR
  - Construct new stormwater controls to reroute stormwater around the west side of the LRCP to a new stormwater outfall
  - Construct new landfill runoff/leachate management system

IKEC will initiate closure of the WBSP and LRCP once the above tasks are complete. Alternative offsite disposal capacity is not available for wastestreams currently entering the WBSP or the LRCP. As acknowledged previously by EPA, it is not feasible to transport wet CCR to an offsite location and it is also not feasible to transport the large volume of non-CCR wastestreams offsite for disposal. Alternative onsite disposal capacity is not currently available and cannot be made available prior to April 11, 2021. In addition, as a result of the extensive existing power production infrastructure on the site, as well as numerous environmental and site-specific physical constraints such as public roadways, floodplains, streams and wetlands near the plant proper, the Clifty Creek Station lacks an alternative suitable location at the plant site for construction of the LVWTS needed to treat the non-CCR wastestreams. There are no other existing impoundments onsite large enough to treat all the non-CCR wastestreams without continued use of the CCR surface impoundments.

As a result, IKEC determined the best and most feasible location to construct the new, lined LVWTS to manage the non-CCR wastestreams currently routed to the WBSP is within a portion of the footprint of the existing WBSP. In addition, a new lined leachate pond and new stormwater collection pond will be constructed within the footprint of the LRCP to receive the non-CCR wastestreams from the landfill, which are currently routed to the LRCP. IKEC has determined that the best and most feasible location to construct the lined ponds are within the footprint of the existing LRCP.

Pre-construction activities, which include geotechnical investigation, survey, design, permitting, development of a commercial contract and procurement of equipment, are underway. Construction of the concrete settling tank, which will be sited within the footprint of the WBSP, is scheduled to commence in Summer 2021, pending receipt of state-approved permits, along with construction of the LVWTS and landfill runoff/leachate management system. Once construction of the new treatment systems is complete, closure of the CCR surface impoundments may begin. Based on the construction schedule set forth in this Demonstration, IKEC estimates all CCR and non-CCR wastestreams will cease flow to the existing WBSP by December 5, 2022 and to the LRCP by April 25, 2023.

As certified herein, the WBSP and LRCP are compliant with all the requirements of the CCR Rule. IKEC will continue to work to ensure that the facility remains in compliance with the applicable CCR Rule obligations until closure of the CCR surface impoundments and any necessary post-closure monitoring efforts are completed. Regular compliance activities, including required groundwater monitoring, are continuing. The WBSP is currently in detection monitoring and the LRCP is in assessment monitoring. All required documents have been placed into the facility's Operating Record and posted on the publicly available website, with notice provided to the Commissioner (i.e. Director) of IDEM as appropriate.

Consequently, because of the demonstrated lack of available alternative disposal capacity before April 11, 2021, as well as the compliance status of the CCR surface impoundments, including system interconnections, complexity, and need for sequencing of the pond closure and water redirect activities, combined with IKEC's diligent and good faith efforts to develop alternative disposal capacity in order to close the CCR surface impoundments, IKEC respectfully requests a site-specific alternative deadline of December 5, 2022, to initiate closure of the WBSP and April 25, 2023, to initiate closure of the LRCP at the Clifty Creek Station.

1.0 INTRODUCTION

On April 17, 2015, the Environmental Protection Agency (EPA) issued the final version of the federal Coal Combustion Residual (CCR) Rule, 40 CFR Part 257, Subpart D, to regulate the disposal of CCR materials generated at coal-fired units. The rule is being administered under Subtitle D of the Resource Conservation and Recovery Act (RCRA, 42 United States Code [U.S.C.] §6901 et seq.).

On August 28, 2020, the EPA Administrator issued revisions to the CCR Rule that require all unlined surface impoundments to cease receipt of CCR and non-CCR waste and initiate closure by April 11, 2021, unless an alternative closure deadline is requested and approved. 40 C.F.R. § 257.101(a)(1) (85 Fed. Reg. 53,516 (Aug. 28, 2020). Specifically, owners and operators of a CCR surface impoundment may seek and obtain an alternative closure deadline by demonstrating that there is currently no alternative capacity available on or off-site and that it is not technically feasible to complete the development of alternative capacity prior to April 11, 2021. 40 C.F.R. § 257.103(f)(1). To make this demonstration, the facility is required to provide detailed information regarding the process the facility is undertaking to develop the alternative capacity. 40 C.F.R. § 257.103(f)(1). Any extensions granted cannot extend past October 15, 2023, except an extension can be granted until October 15, 2024, if the impoundment qualifies as an "eligible unlined CCR surface impoundment" as defined by the rule. 40 C.F.R. § 257.103(f)(1)(vi). Regardless of the maximum time allowed under the rule, EPA explains in the preamble to the Part A rule that each impoundment "must still cease receipt of waste as soon as feasible, and may only have the amount of time [the owner/operator] can demonstrate is genuinely necessary." 85 Fed. Reg. 53,546.

IKEC's Clifty Creek Station is subject to the CCR Rule and as such is required to ensure its CCR units maintain compliance with the requirements of the CCR Rule. Pursuant to the requirements set forth in the Rule, this document serves as IKEC's Demonstration for a Site-Specific Alternative to Initiation of Closure Deadline for the existing CCR surface impoundments at the Clifty Creek Station, located near the town of Madison, Indiana in Jefferson County. This document seeks EPA approval under 40 CFR §257.103(f)(1) (for "Development of Alternative Capacity Infeasible") for the Clifty Creek Station WBSP and LRCP to continue to receive CCR and/or non-CCR wastestreams by demonstrating that the CCR and/or non-CCR wastestreams must continue to be managed in the CCR surface impoundment because it is infeasible to complete the measures necessary to provide alternative disposal capacity by April 11, 2021.

To obtain an alternative closure deadline under 40 C.F.R. § 257.103(f)(1), a facility must meet the following three criteria:

1. § 257.103(f)(1)(i) - There is no alternative disposal capacity available on-site or off-site. An increase in costs or the inconvenience of existing capacity is not sufficient to support qualification;
2. § 257.103(f)(1)(ii) - Each CCR and/or non-CCR wastestream must continue to be managed in that CCR surface impoundment because it was technically infeasible to complete the measures necessary to obtain alternative disposal capacity either on or off-site of the facility by April 11, 2021; and
3. § 257.103(f)(1)(iii) - The facility is in compliance with all the requirements of the CCR rule.

To demonstrate that the first two criteria above have been met, 40 C.F.R. § 257.103(f)(1)(iv)(A) requires the owner or operator to submit a work plan that contains the following elements:

- A written narrative discussing the options considered both on and off-site to obtain alternative capacity for each CCR and/or non-CCR wastestream, the technical infeasibility of obtaining alternative capacity prior to April 11, 2021, and the option selected and justification for the alternative capacity selected. The narrative must also include all of the following:
    - An in-depth analysis of the site and any site-specific conditions that led to the decision to select the alternative capacity being developed;
    - An analysis of the adverse impact to plant operations if the CCR surface impoundment in question were to no longer be available for use; and
    - A detailed explanation and justification for the amount of time being requested and how it is the fastest technically feasible time to complete the development of the alternative capacity.
- A detailed schedule of the fastest technically feasible time to complete the measures necessary for alternative capacity to be available, including a visual timeline representation. The visual timeline must clearly show all of the following:
    - How each phase and the steps within that phase interact with or are dependent on each other and the other phases;
    - All of the steps and phases that can be completed concurrently;
    - The total time needed to obtain the alternative capacity and how long each phase and step within each phase will take; and
    - At a minimum, the following phases: engineering and design, contractor selection, equipment fabrication and delivery, construction, and start up and implementation.

- A narrative discussion of the schedule and visual timeline representation, which must discuss the following:
    - Why the length of time for each phase and step is needed and a discussion of the tasks that occur during the specific step;
    - Why each phase and step shown on the chart must happen in the order it is occurring;
    - The tasks that occur during each of the steps within the phase; and
    - Anticipated worker schedules.
- A narrative discussion of the progress the owner or operator has made to obtain alternative capacity for the CCR and/or non-CCR wastestreams. The narrative must discuss all the steps taken, starting from when the owner or operator initiated the design phase up to the steps occurring when the demonstration is being compiled. It must discuss where the facility currently is on the timeline and the efforts that are currently being undertaken to develop alternative capacity.

To demonstrate that the third criterion above has been met, 40 C.F.R. § 257.103(f)(1)(iv)(B) requires the owner or operator to submit the following information:

- A certification signed by the owner or operator that the facility is in compliance with all of the requirements of 40 C.F.R. Part 257, Subpart D;
- Visual representation of hydrogeologic information at and around the CCR unit(s) that supports the design, construction and installation of the groundwater monitoring system. This includes all of the following:
    - Map(s) of groundwater monitoring well locations in relation to the CCR unit(s);
    - Well construction diagrams and drilling logs for all groundwater monitoring wells; and
    - Maps that characterize the direction of groundwater flow accounting for seasonal variations.
- Constituent concentrations, summarized in table form, at each groundwater monitoring well monitored during each sampling event;
- A description of site hydrogeology including stratigraphic cross-sections;
- Any corrective measures assessment conducted as required at § 257.96;
- Any progress reports on corrective action remedy selection and design and the report of final remedy selection required at § 257.97(a);
- The most recent structural stability assessment required at § 257.73(d); and
- The most recent safety factor assessment required at § 257.73(e).

2.0 WORKPLAN

To demonstrate that the criteria in 40 C.F.R. § 257.103(f)(1)(i) and (ii) have been met, the following is a workplan, consisting of the elements required by § 257.103(f)(1)(iv)(A). IKEC has elected to install a system of multiple technologies to cease routing flow to the CCR surface impoundments, including a concrete settling tank for boiler slag and a new lined non-CCR low volume wastewater treatment system for the water balance flows. This workplan documents that there is no alternative capacity available on or off-site for each of the CCR and/or non-CCR wastestreams that IKEC plans to continue to manage in the surface impoundments and discusses the options considered for obtaining alternative disposal capacity. It also provides a detailed schedule for obtaining the selected alternative capacity, including a narrative description of the schedule and an update on the progress already made toward obtaining the alternative capacity.

2.1 Documentation of No Alternative Disposal Capacity and Approach to Obtain Capacity

The Clifty Creek Station is owned and operated by IKEC and is comprised of six operating coal-fired units with a combined 1,304 net MW of generation. The plant is located along the Ohio River in Jefferson County, just west of Madison, Indiana. Clifty Creek Station has one active CCR surface impoundment, the WBSP, and one inactive CCR surface impoundment, the LRCP, located as shown on the site plan in Appendix A.

The WBSP was constructed in 1955 during the development of the plant and is approximately 75 acres. The pond receives all the boiler slag sluice flows from Units 1-6 as well as the balance of non-CCR wastewater flows from the plant. Boiler slag sluice flows enter the WBSP (identified as the West Bottom Ash Pond on the water balance provided in Appendix B) on the northeast end and are conveyed through the pond to allow for settling of solids prior to discharge to the Ohio River via an NPDES permitted outfall (Outfall 002). The WBSP compliance info is summarized in Table 2-1.

Table 2-1: Clifty Creek Station WBSP Summary

CCR Surface Impoundment Name	Alternate Designation (see Appendix B)	Year Placed in Service	Impoundment Size (acres) / Storage Volume (acre-feet)	Lined?	Meets Location Restrictions?	Groundwater Status
West Boiler Slag Pond	West Bottom Ash Pond	1955	75 / 3,330	No	Yes	Detection Monitoring
Landfill Runoff Collection Pond	None	1957	40 / 1,549	No	Yes	Assessment Monitoring

The Clifty Creek Station operates under NPDES permit IN0001759, which was most recently issued by IDEM in 2017, and is set to expire April 30, 2022. The current permit incorporates the ELGs as issued in 2015 and requires compliance with the zero-discharge standard for boiler slag by April 1, 2022; however, IKEC will be working with IDEM's Office of Water Quality to modify this permit requirement to align it with the compliance strategy activities and schedule proposed herein, as well as the revisions to the ELG Rule (85 Fed. Reg. 64,650 (October 13, 2020). IKEC has been making good faith effort to meet the original compliance schedule deadline of April 2022 contained in the facility's current NPDES permit, which will require the closure of the WBSP.

Due to the complexity of the WBSP closure, the CCR unit will be closed in phases. A closure application for Phase I closure of the WBSP was submitted to IDEM's Office of Land Quality in February 2020, after working with IDEM since April 2019 to develop that application. However, due to impacts realized due to COVID-19, as well as other impacts beyond the control of IKEC, an approval of the Phase I closure plan has yet to be secured, which directly impacts its ability to begin activities associated with modifying the facility to meet the compliance schedule assigned in the facility's NPDES permit by IDEM's Office of Water Quality. IKEC understands that IDEM intends to use the Indiana Restricted Waste Site (RWS) regulations to review the proposed closure design, as well as to manage its construction activities. Specifically, IDEM intends to permit the closure activities, which will include the construction activities associated with the boiler slag settling basins and new LVWTS, as a Type I RWS. A Type I RWS, which is normally required as a result of the characterization of the waste to be placed in the restricted waste site, requires the most stringent level of monitoring and containment. As a result of this proposed permitting scheme, IKEC will be unable to initiate construction activities until a final permit is received from IDEM for Phase I. Further, feedback from IDEM's initial review process of the Phase I closure design is being incorporated into the design of the subsequent phases. As a result, closure applications associated with Phases II – IV have not yet been submitted to IDEM. IKEC intends to complete the design work associated with these phases expeditiously and seek approval from IDEM.

The LRCP was constructed between 1956 and 1957 during the development of the plant and is approximately 40 acres in size. The CCR surface impoundment is an inactive impoundment and has not received CCR materials since 1986; however, this impoundment still receives non-CCR wastestreams. The area serves predominantly as a stormwater pond managing the flow from the western portion of IKEC's CCR landfill as well as significant watershed acreage from offsite. The LRCP is also intended to receive leachate from the western portion of the facility's CCR landfill once additional landfill phases are developed in that area. The LRCP discharges through the Outfall 001 structure located in the southwest corner of the impoundment.

2.1.1 CCR Wastestreams

As outlined above, the WBSP receives boiler slag and mill rejects. Boiler slag is removed from the bottom of the boilers via the existing bottom ash water transport system. Mill rejects from the coal mills are removed in batch operation and sluiced to this impoundment. The WBSP also receives flow from the current FGD wastewater systems for Clifty Creek Station Units 1-6, which use an existing physical/chemical treatment system to remove FGD solids from the current discharge stream, as well as a variety of other low volume process wastewater and storm water runoff flows described in greater detail in Section 2.1.2. These additional flows are considered non-CCR wastestreams.

The WBSP must remain available for treatment of the CCR wastestreams until other projects that are currently underway to eliminate the discharge of ash transport water (and comply with the ELG rule) can be completed. These projects are described in detail within Section 2.1.6. Once these efforts are completed, Clifty Creek Station's CCR wastestreams will no longer be routed to the CCR surface impoundments. Table 2-2 summarizes the status of each of the CCR wastestreams throughout the period of the requested extension.

The LRCP currently does not receive any CCR wastestreams and is considered to be an inactive surface impoundment.

Table 2-2: Clifty Creek Station CCR Wastestreams

CCR Wastestream	Average Flow (MGD)	Description	IKEC Notes
Boiler Slag	2.90	Sluiced to existing West Boiler Slag Pond	The boiler slag ash transport water is sluicing CCR material, and this stream cannot be routed to any location onsite other than the existing CCR surface impoundment. IKEC has elected to install a boiler slag settling tank as part of a high recycle rate system to effectively eliminate this wastestream consistent with the updated CCR and ELG regulations by the requested site-specific deadline to initiate closure.

2.1.2 Non-CCR Wastestreams

Currently, Clifty Creek Station utilizes the WBSP to manage the majority of the non-CCR wastestreams on the plant site. The existing water balance is included in Appendix B of this demonstration. IKEC evaluated each non-CCR wastestream placed in the WBSP at Clifty Creek Station. For the reasons discussed below in Table 2-3, each of the following non-CCR wastestreams must continue to be placed in the WBSP due to lack of alternative capacity both on and off-site.

Table 2-3: Clifty Creek Station WBSP Non-CCR Wastestreams

Non-CCR Wastestream	Average Flow (MGD)	Description	IKEC Notes
Boiler room sump	7.98	Includes ash hopper overflow, generator sump flows, water treating plant, sump agitation water, and groundwater/general station use flows.	There is no existing alternative disposal capacity for these comingled wastestreams. This flow will be routed to the new lined LVWTS but must be treated within the remaining WBSP footprint while the LVWTS is being constructed. The volume of this flow is not feasible to segregate and route to temporary treatment measures.
Air heater wash flows	N/A (outage flow only)	Flows collected in the boiler room sumps before being pumped to the WBSP	This flow must be routed to the new LVWTS prior to discharge. There is no existing alternative disposal capacity for this wastestream, and this flow is comingled with the boiler room sump flows from the operating units before being routed to the WBSP. The volume of this combined flow (approximately 4 million gallons) is not feasible to segregate and route to temporary treatment measures.

Non-CCR Wastestream	Average Flow (MGD)	Description	IKEC Notes
FGD wastewater treatment system	0.37	Flows pumped to WBSP	There is no existing alternative disposal capacity for this wastestream. This flow could potentially be rerouted to an existing or new Outfall with additional, pumps, piping, wastewater sampling/characterization, and permit modifications; however, IKEC has chosen to devote its project resources, as well as those of IDEM, to the permanent solution (the necessary construction of the site LVWTS) rather than developing a separate project to reroute this *de minimis* wastestream away from the WBSP during the requested demonstration.
Coal yard sump flows	0.04 (estimated 5.60 for 10-year, 24-hour storm)	Flows pumped to WBSP (includes flow from East Area Runoff Collection Pond)	There is no existing alternative disposal capacity for this wastestream. Significant surge capacity must be provided for high flows during rain events and it is not feasible to segregate and route this flow to another existing non-CCR basin or to temporary treatment measures.
Drainage from fly ash silo and blower building	0.10	Flows pumped to WBSP	There is no existing alternative disposal capacity for this wastestream. This flow could potentially be rerouted to an existing or new Outfall with additional, pumps, piping, wastewater sampling/characterization, and permit modifications; however, IKEC has chosen to devote its project resources, as well as those of IDEM, to the permanent solution (the necessary construction of the site LVWTS) rather than developing a separate project to reroute this *de minimis* wastestream away from the WBSP during the requested demonstration.
FGD waste sump	0.03	Flows pumped to WBSP	There is no existing alternative disposal capacity for this wastestream. This flow could potentially be rerouted to an existing or new Outfall with additional, pumps, piping, wastewater sampling/characterization, and permit modifications; however, IKEC has chosen to devote its project resources, as well as those of IDEM, to the permanent solution (the necessary construction of the site LVWTS) rather than developing a separate project to reroute this wastestream away from the WBSP during the requested demonstration.

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Non-CCR Wastestream	Average Flow (MGD)	Description	IKEC Notes
Stormwater Runoff and Leachate from East Portion of Landfill	0.14 (estimated 1.94 for 10-year, 24-hour storm)	Leachate and non-contact water from landfill and offsite drainage areas into WBSP	There is no existing alternative disposal capacity for this wastestream. IKEC could potentially reroute these flows north of the WBSP to Clifty Creek as part of the drainage modifications for the LRCP closure; however, the current plan is for the WBSP closure design to incorporate a flat-bottomed ditch which will redirect this flow to a new outfall to the Ohio River.
Landfill Leachate and Stormwater Runoff from West Portion of Landfill	0.796 (estimated 6.18 for 10-year, 24-hour storm)	Leachate, contact water from landfill runoff, and non-contact water from offsite drainage areas into LRCP	There is no existing alternative disposal capacity for this wastestream. IKEC plans to construct a new treatment system within the footprint of the LRCP to receive this flow.

The WBSP must remain available for treatment of non-CCR wastestreams until a new non-CCR basin, also referred to as the LVWTS, can be constructed and these flows can be routed to that new facility. Based on the lack of available space at the plant site as discussed in Section 2.1.3 (see also Figure 3 in Appendix A), the LVWTS will be built within a portion of the WBSP footprint.

The LRCP receives landfill stormwater runoff, as well as stormwater flow from more than 500 acres of watershed, most of which is not owned by IKEC and includes the runoff from Indiana Highway 56 and privately owned property. The LRCP was also planned to receive additional leachate and stormwater runoff from the west portion of the landfill once new landfill phases are developed in that area. The LRCP must remain available for stormwater flows until IKEC can construct new stormwater controls capable of managing storm water flowing into IKEC's present controls, including the management and redirection of stormwater originating from off-site property. In addition, a new leachate treatment system will need to be constructed to manage the leachate from future phases of the facility's CCR landfill. Based on the lack of available space as discussed in Section 2.1.3 (see also Figure 3 in Appendix A), the new landfill runoff/leachate management system will be constructed in the footprint of the existing LRCP. The new landfill runoff/leachate management system cannot be constructed until stormwater from the offsite watershed areas, which include stormwater flows from portions of Indiana Highway 56, are diverted around the LRCP. As part of this diversion, IKEC will need to secure multiple environmental permits from IDEM, and potentially IDNR.

2.1.3 Site-Specific Conditions Supporting Alternative Capacity Approach – § 257.103(f)(1)(iv)(A)(1)(i)

As shown on Figure 1 in Appendix A, Clifty Creek Station is bounded by the Ohio River to the south, Crooked Creek and a golf course to the east, Indiana Highway 56 to the north, and farmland and residential areas to the west. The site is also bisected by Clifty Creek and a limestone ridge known as the Devil's Backbone. Most of the Clifty Creek Station property which is outside of the existing floodplain is occupied with critical infrastructure including the CCR surface impoundment, the landfill and LRCP, the coal storage pile, the material handling equipment, the pollution control equipment (including electrostatic precipitators, selective catalytic reduction systems, JBR scrubber systems, and the FGD wastewater treatment system), the switchyard, and transmission lines. Figure 3 in Appendix A provides additional detail of the existing site conditions, including the property boundaries, floodplain limits, topography, as well as the proposed settling tank, LVWTS, and landfill pond footprints.

Based on the limited space available onsite at Clifty Creek Station, it is not possible to construct a new lined LVWTS with associated piping, chemical feed, and power supply that is large enough to receive non-CCR wastestreams and be outside the CCR surface impoundment footprint. By constructing the new lined LVWTS within the existing footprint of the WBSP, the Clifty Creek Station would also avoid the need to impact waters of the U.S. and other natural resources in the Clifty Creek watershed as part of this project.

In addition to the aforementioned facility boundaries, the LRCP is also significantly impacted by the immediate topography surrounding the facility. The LRCP is confined to the north by steep, in some cases nearly vertical slopes, and to the south by the steep slopes of the Devil's Backbone. These slopes, as well as the farmland, the residential areas, and portions of Indiana Highway 56, all contribute to the stormwater currently managed in the LRCP. IKEC has determined that the topography and existing conditions of watershed area not owned or managed by the facility do not allow for the stormwater to be redirected or managed in an existing alternative location onsite, nor can IKEC prevent this off-site drainage area from flowing into the LRCP drainage area.

Based on the foregoing facts, IKEC cannot cease the flow of CCR and non-CCR wastestreams and initiate closure of the WBSP until the concrete settling tank construction is complete, the new lined LVWTS is constructed within the footprint of the WBSP, and the non-CCR wastestreams are rerouted to the new lined LVWTS. Additionally, IKEC cannot cease non-CCR wastestreams to the LRCP until the new stormwater management system and leachate system are constructed. Given the complexity of these projects, weather-driven impacts, and the need to sequence the activities as outlined above, those actions cannot be completed prior to April 11, 2021. Thus, the conditions at Clifty Creek Station demonstrate that no alternative disposal capacity is available on-site or off-site, satisfying the requirement of 40 CFR 257.103(f)(1)(i)(A), and IKEC respectfully requests a site-specific extension of the deadline to initiate closure of the CCR surface impoundment until the date on which those actions are expected to be completed.

2.1.4 Impact to Plant Operations if Alternative Capacity Not Obtained – § 257.103(f)(1)(iv)(A)(1)(ii)

IKEC's entire generating capacity is sold to its parent (OVEC) at cost under the FERC approved OVEC-IKEC Power Agreement, and such capacity (along with capacity owned and operated directly by OVEC at its other power plant) is exclusively committed and available to OVEC's owners or their affiliates (who are public utilities or electric power cooperatives, collectively referred to herein as the "Sponsoring Companies")[1] under the terms of the FERC approved Inter-Company Power Agreement (ICPA). Under the ICPA, the Sponsoring Companies are responsible for their share of OVEC's costs and expenses, including for debt and other long-term obligations. The Sponsoring Companies and OVEC entered into an amended and restated ICPA, effective as of August 11, 2011, which extends its term to June 30, 2040. The OVEC-IKEC Power Agreement has the same extended term.

OVEC also supplies energy to the DOE's Portsmouth Uranium Enrichment facility located in Piketon, Ohio. The DOE is OVEC's only non-ICPA customer for power and energy. OVEC serves the DOE under a cost-based arranged power agreement approved by the Public Utilities Commission of Ohio (PUCO). Under this agreement, OVEC purchases energy from the wholesale energy market and resells such energy to DOE as needed in real time to meet all energy needs of the Portsmouth Uranium Enrichment Facility (which has been in the process of demolition and deconstruction since it permanently ceased operations). OVEC's energy purchases to serve the DOE are made solely from the real-time market managed by the PJM Interconnection LLC (PJM) Regional Transmission Organization.

[1] OVEC's current Sponsoring Companies (and their percentage of obligations under the ICPA) are as follows: Allegheny Energy Supply Company LLC (subsidiary of FirstEnergy Corp (FirstEnergy)), 3.01%; Appalachian Power Company (subsidiary of American Electric Power Company, Inc. (AEP)), 15.69%; Buckeye Power Generating, LLC (subsidiary of Buckeye Power, Inc.), 18.00%; The Dayton Power and Light Company (subsidiary of AES Corp), 4.90%; Duke Energy Ohio, Inc. (subsidiary of Duke Energy Corporation), 9.00%; Energy Harbor Corp, 4.85%; Indiana Michigan Power Company (subsidiary of AEP), 7.85%; Kentucky Utilities Company (subsidiary of PPL Corp (PPL)), 2.50%; Louisville Gas and Electric Company (subsidiary of PPL), 5.63%; Monongahela Power Company (subsidiary of FirstEnergy), 0.49%; Ohio Power Company (subsidiary of AEP), 19.93%; Peninsula Generation Cooperative (subsidiary of Wolverine Power Supply Cooperative, Inc.), 6.65%; and Southern Indiana Gas and Electric Company (subsidiary of CenterPoint Energy, Inc.), 1.50%.

OVEC is a member of PJM; however, it does not sell electric capacity or energy to anyone other than at wholesale to the Sponsoring Companies under the ICPA, and at retail to the DOE under the PUCO approved agreement through resale of energy made available by PJM. Under the terms of the ICPA, the Sponsoring Companies either utilize their allocation of electric capacity and energy for their own retail customers (residential, commercial, and industrial), or sell such electric capacity and energy at wholesale, including in PJM-managed energy and capacity markets. In addition, OVEC maintains in excess of 700 miles of 345 KV transmission lines, all of which are subject to the management of PJM.

The CCR impoundments are the primary component of the existing wastewater treatment systems at the Clifty Creek Station. If the CCR Rule were to require closure of the CCR impoundments at the Clifty Creek Station prior to the requested site-specific deadlines, the Clifty Creek Station would be forced to cease operation, and the Sponsoring Companies would not receive their allocation of electric capacity and energy from the Clifty Creek Station to supply electricity to their retail public utility and electric power cooperative customers in Indiana and many neighboring states (or, as applicable, to allow such Sponsoring Companies to sell their allocation of such capacity or energy into power markets for the benefit of such ratepayers). A cessation of operations at the Clifty Creek Station also could cause increased and accelerated costs to OVEC and IKEC, including accelerated costs of demolition and decommissioning of the Clifty Creek Station and possible efforts by OVEC's creditors and other counter-parties to try to accelerate their collection of existing debt or other long-term obligations, which (in turn) might trigger sizable and accelerated payment obligations for the Sponsoring Companies under the ICPA. In addition, an unplanned loss of such generating capacity might negatively impact grid stability and power markets in the PJM and surrounding region.

As described in Sections 2.1.1, 2.1.2, and 2.1.6 of this demonstration, in order to continue to operate, generate electricity, and ultimately comply with the CCR Rule, the ELGs, and the facility's NPDES permit conditions, the Clifty Creek Station must continue to use the WBSP for treatment of both CCR and non-CCR wastestreams and the LRCP for the treatment of non-CCR wastestreams until alternative disposal capacity can be developed. This development includes the following primary activities that must be completed in order to initiate closure of the CCR surface impoundment:

- WBSP:
  - Secure all applicable permits or permit modifications from IDEM and IDNR
  - Construct new concrete settling tank within the WBSP footprint to receive the boiler slag material

  - Reroute boiler slag and mill reject sluice flows to the new concrete settling tank and establish a high recycle rate system
  - Construct a new lined LVWTS within the WBSP footprint
  - Reroute non-CCR flows to the new lined LVWTS
- LRCP:
  - Secure all applicable permits or permit modifications from IDEM and IDNR
  - Construct new stormwater controls to reroute stormwater around the west side of the LRCP to new stormwater outfall
  - Construct new landfill runoff/leachate management system

2.1.5 Options Considered Both On and Off-Site to Obtain Alternative Capacity

As EPA explained in the preamble of the 2015 rule, it is typically not feasible for sites that sluice CCR material to an impoundment to eliminate the impoundment and dispose of the material offsite. See 80 Fed. Reg. 21,301, 21,423 (Apr. 17, 2015) ("[W]hile it is possible to transport dry ash off-site to [an] alternate disposal facility that is simply not feasible for wet-generated CCR. Nor can facilities immediately convert to dry handling systems."). IKEC recognizes this fact and agrees with EPA that offsite disposal is not an option for Clifty Creek Station. IKEC also agrees it is not feasible to provide offsite treatment of the large volume of non-CCR wastewaters currently routed to the WBSP. Off-site disposal of these sluiced CCR and non-CCR wastestreams would require both on-site temporary storage and significant daily tanker truck traffic. The required daily tanker trucks (assuming 7,500-gallon capacity per truck) for each of the CCR and non-CCR sluiced wastestreams are summarized as follows:

- <u>Boiler Slag sluice to WBSP (2.90 MGD):</u> Approximately 380 daily trucks would be required, if a Publicly Owned Treatment Works (POTW) could be identified to receive it.
- <u>Boiler room sump flows to WBSP (7.98 MGD):</u> Approximately 1,060 daily trucks would be required.
- <u>FGD wastewater treatment system flows to WBSP (0.37 MGD):</u> Approximately 50 daily trucks would be required.
- <u>Coal yard sump flows to WBSP (0.04-5.60 MGD):</u> Approximately 5 daily trucks would be required, increasing up to over 740 daily trucks during rain events.
- <u>Drainage from fly ash silo and blower building (0.10 MGD):</u> Approximately 13 daily trucks would be required.
- <u>FGD waste sump flows to WBSP (0.03 MGD):</u> Approximately 4 daily trucks would be required.

- Stormwater Runoff and Leachate from East Portion of Landfill to WBSP (0.14-1.94 MGD): Approximately 18 daily trucks would be required, increasing up to over 250 daily trucks during rain events.
- Landfill Leachate and Stormwater Runoff from West Portion of Landfill to LRCP (0.796-6.18 MGD): Approximately 106 daily trucks would be required, increasing up to over 820 daily trucks during rain events.

This tank traffic as well as the significant daily tanker truck volume for offsite disposal (over 1,600 trucks per day during normal operations and over 3,300 trucks per day during rain events) would result in increased potential for safety and noise impacts and further increases in fugitive dust, greenhouse gas emissions and carbon footprint which may require a Prevention of Significant Deterioration (PSD) permit and modification under the Clean Air Act Permit Program if the calculated increases in emissions are over the PSD limits. This increased traffic during rain events is also difficult to plan for and reliably perform in this location, regardless of whether suitable disposal locations can be identified. Setting up contractual arrangements for a local POTW to accept the wastewater would prove to be difficult since they also have to meet NPDES discharge limits. Therefore, most POTW's have their own permitting process to allow industry to discharge to their facilities, and they may be required to modify their NPDES discharge permit adding time to the overall compliance schedule. The potential for leaks/spills from the tank system or transportation of the wastewater offsite does also exist. Furthermore, the temporary wet storage needed to accommodate off-site disposal would require reconfiguration, design, installation, and associated environmental permitting that would extend the overall compliance schedule. Consequently, there are no feasible offsite-disposal options for the wet-generated wastestreams at Clifty.

The other pond onsite (the East Area Runoff Collection Pond, also referred to as the FGD Runoff Collection Pond) is not large enough to independently treat these flows without the continued use of the CCR surface impoundment. Further, the pond water is collected and pumped to the WBSP with the coal pile runoff, where it is discharged through the existing NPDES outfall structure. Any additional wastewater flows would result in an inundation of the coal yard with wastewater due to the limitation of the existing wastewater conveyance system. Eliminating flow to the WBSP would require a new permitted outfall and discharge structure at the East Area Runoff Collection Pond. Thus, IKEC must pursue onsite options for the handling of CCR and non-CCR wastestreams that are currently directed to the CCR surface impoundments.

The options considered for alternative disposal capacity of the wastestreams currently routed to the WBSP and LRCP are summarized in Table 2-4. For additional details on the CCR and non-CCR wastestreams, please refer to Table 2-2 and Table 2-3, respectively.

Table 2-4: Clifty Creek Station Alternatives for Disposal Capacity

Alternative Capacity Technology	Average Time (Months)[1]	Feasible at Clifty?	Selected?	IKEC Notes
Conversion to dry handling	33.8	Yes	Yes	Fly ash is currently dry handled at Clifty. A dry boiler slag handling solution was considered, but ultimately not selected due to business risk associated with mechanical equipment failures affecting six operating units. IKEC will install new concrete settling tank as part of a high recycle rate system to handle boiler slag. This solution was selected in May 2020 and is scheduled to be implemented by November of 2022. This is an aggressive schedule for compliance across all six units at the site, and significantly faster than the average time estimated by EPA.
Non-CCR wastewater basin	23.5	Yes	Yes	A new landfill runoff/leachate management pond and a new LVWTS are being constructed as one part of the solution to comply with the new requirements. The volume of non-CCR wastestreams cannot be contained within the existing non-CCR basin onsite with adequate residence time to meet discharge limits. There is not adequate real estate onsite (see Figure 3 in Appendix A), or within a reasonable distance, to construct additional non-CCR basins outside the footprint of the WBSP and LRCP, which extends the schedule required for construction of the new treatment systems since inflows into the ponds will need to be diverted around the work areas prior to initiating construction. EPA should note that while additional time is required for this construction based on the Clifty site conditions, IKEC will begin work grading/stabilizing/capping material in the WBSP and LRCP as required for final closure of the ponds during the requested extension.
Wastewater treatment facility	22.3	Yes	Yes	A chemical feed system is being constructed as part of the LVWTS.

Alternative Capacity Technology	Average Time (Months)[1]	Feasible at Clifty?	Selected?	IKEC Notes
New CCR surface impoundment	31	No	No	There is not adequate real estate onsite (see Figure 3 in Appendix A), or within a within a reasonable distance of the power plant, to construct a new CCR surface impoundment. Additionally, permitting required to construct a new surface impoundment would delay the cessation of waste streams and closure of the CCR impoundments past the deadline requested, and would not alone provide compliance with ELG.
Retrofit of a CCR surface impoundment	29.8	Yes	No	A retrofit alone would not have allowed for compliance with ELG. This would require complete removal of the CCR from the WBSP, which would extend the overall compliance schedule to allow for this removal while simultaneously continuing to use the WBSP to receive CCR and non-CCR wastestreams (that cannot be directed to an alternate location onsite).
Multiple technology system	39.1	Yes	Yes	This is being implemented as described above to include the concrete settling tank for boiler slag, new LVWTS (non-CCR basin and associated chemical feed system), and new non-CCR basins for landfill stormwater and leachate. This solution was selected in May 2020 and is scheduled to be implemented by April of 2023, which is an aggressive schedule for compliance across all six units at the site, and slightly faster than the average time estimated by EPA.
Temporary treatment system	Not defined	No	No	A new temporary treatment system for non-CCR wastestreams would need to handle/treat an average daily flow of 9.46 MGD, not including stormwater contributions. It is not technically feasible to build temporary tanks to provide this level of treatment during the construction of the LVWTS, and as shown in Figure 3 in Appendix A, there is not enough available space to install this temporary equipment. IKEC has chosen to focus on implementing the necessary measures for the selected technologies described above as soon as possible rather than try to develop temporary solutions for certain low volume wastestreams.

[1]From Table 3. See 85 Fed. Reg. at 53,534.

IKEC began evaluating CCR handling technologies in 2017 with the assistance of BMcD. The evaluation for Clifty Creek Station had to consider not only the evolving requirements of the CCR Rule, but also the unknown revisions to the ELGs that would likely impact the approaches being considered for boiler slag management. BMcD completed an evaluation that investigated multiple technology options for boiler slag handling as described in Table 2-5, below.

Table 2-5: Boiler Slag Handling Technologies

Alternative Capacity Technology	Selected?	IKEC Notes
Underboiler Drag Chain Conveyor System	No	Not feasible due to space constraints under the boilers
Remote Drag Chain Conveyor System	No	Not selected due to concerns with equipment redundancy for six operating units and due to potential reliability risks associated with mechanical equipment in a highly abrasive environment
Dry Belt/Tray Conveying System	No	Not feasible due to boiler design
Proprietary B&W Submerged Grind Conveyor System	No	Not feasible due to space constraints under the boilers
Traditional Water Treatment Style Slag Handling System	No	Not practical; still in conceptual design phase
Pneumatic Conveying System	No	Not feasible due to boiler design
Rapid Remote Dewatering System	No	Not practical; still in conceptual design phase
Composite Liner Retrofit	No	Feasible; however, not compliant with ELG rule for limiting discharge of ash transport water
Concrete Settling Tank w/ Water Recirculation System	Yes	Selected

2.1.6 Approach to Obtain Alternative Disposal Capacity

Following the 2017 study, IKEC identified a preferred technology for further review, which included the concrete settling tank for boiler slag. This selection was based on comparison of each of the alternatives that were deemed to be technically feasible at Clifty Creek. IKEC worked with Stantec to develop WBSP closure phasing and grading design options which incorporate a concrete settling tank, also referred to as the Boiler Slag Handling System (BSHS), and new LVWTS for plant non-CCR wastestreams. The Phase

I permit-level drawings were prepared in January of 2020. Stantec continued to refine the design of the LVWTS and WBSP closure as part of the front-end engineering design (FEED) efforts.

In 2020 (following EPA release of the proposed ELG and CCR rule revisions), IKEC hired BMcD to prepare a PDR for installing the concrete settling tank within the footprint of the existing WBSP. The concrete settling tank will consist of three chambers, as shown on Figure 2 in Appendix A, which are sized to settle boiler slag material and mill rejects from the sluice water. Overflow from the chambers will collect in a recycle tank for recirculation back through the boiler slag sluicing system. For this system operation, sluice water will be directed to one of the chambers, with the second chamber being dewatered and cleaned of boiler slag material, and the third chamber in waiting to receive sluice flows or upset flows if needed. The tank will be constructed over existing CCR material. As discussed in more detail in Section 2.3, the footprint of the BSHS will be pre-loaded prior to installing the concrete structure to consolidate the material and reduce the potential for differential settlement and the resulting cracking. The tank is being designed to meet ACI 350-06 requirements for water retaining concrete structures with normal environmental exposure. Normal environmental exposure is defined as exposure to liquids with a pH greater than 5, or exposure to sulfate solutions 1000 ppm or less. The tank location is shown on Figure 2 in Appendix A. Typical plan and section sketches are also included in Appendix A.

As noted above, Stantec continues to develop the LVWTS design. The north basin (i.e. the primary basin) is currently sized to handle 4 million gallons of air heater wash with additional storage for a 50-year, 24-hour storm event and 2-feet of dead storage for solids accumulation. The south basin (i.e. secondary basin) is sized to provide a minimum of 24 hours of detention time at the average daily flow rate. The LVWTS will discharge to the Ohio River through a new NPDES outfall. The two basins will operate in series except during air heater wash events where wash water will be directed to the primary basin and all other flows will bypass the primary basin and be directed to the secondary basin. The preliminary sizing and location of the new lined LVWTS is shown in Figure 2 in Appendix A, and preliminary plan and section drawings prepared by Stantec are included in Appendix D.

The LVWTS will also be constructed over existing CCR material in order to minimize the overall compliance schedule by limiting the amount of offsite borrow material required to complete the project and to balance cut and fill within the existing basin. Furthermore, removing all of the CCR material from the WBSP and constructing a new lined LVWTS is not feasible while all of the CCR and non-CCR wastestreams continue to be routed to this facility. The construction must occur in the upper portions of the WBSP, while the lower portions continue to receive these flows. The LVWTS will receive a composite liner system. Preliminary cross sections of the LVWTS and details of the composite liner system are provided in Appendix D. The footprint of the new LVWTS will be graded and stabilized prior to installing the new composite liner system. In addition to providing containment for the wastestreams discharged to the new LVWTS, the composite liner will also act as a cover system over underlying CCR materials which remain. Stantec is conducting a geotechnical investigation to better characterize properties of the existing CCR material and determine structural stability characteristics for the LVWTS.

IKEC also worked with Stantec to develop LRCP closure phasing and grading design options which incorporate the new stormwater management controls and landfill runoff and leachate ponds. These systems will either discharge via a stormwater outfall to Clifty Creek, an internal outfall to new stormwater ditches built into the WBSP closure design, or discharge to the Ohio River through NPDES Outfall 001. The proposed closure phasing was provided in March of 2020 and is included in Appendix D.

Based on the work completed to date, IKEC and BMcD identified the following primary scope items:

- New concrete settling tank, constructed within the footprint of the existing WBSP, to settle boiler slag and mill rejects and recycle water to the boiler slag sluicing system. This system is also referred to as the BSHS. See Appendix A for preliminary sketches showing the tank location and pond sections, as well as plan and section views of the structural components.
- Re-grading of boiler slag material to support construction of the new concrete settling tank and LVWTS.
- New lined LVWTS constructed south of the concrete settling tank, which will treat non-CCR wastestreams generated at the Clifty Creek Station. See Appendix D for preliminary plan and section drawings prepared by Stantec.
- Chemical treatment systems for the concrete settling tank and new lined LVWTS to promote settlement of fine particles and adjust pH if required.
- Diversion of offsite stormwater around the LRCP to a new stormwater outfall to support impending pond closure activities. See Appendix D for preliminary concept sketches.
- New landfill stormwater runoff and leachate management systems as part of the LRCP closure activities. See Appendix D for preliminary closure design concept sketches.

Each of the noted scope items is required to provide alternative treatment for the CCR and non-CCR wastestreams that currently flow to the WBSP and LRCP and initiate closure of the unlined CCR surface impoundments as required by the CCR Rule. The LVWTS, BSHS, and LRCP design features are designed to prevent migration of wastewaters into the underlying CCR material, and IKEC believes these designs are environmentally responsible and will meet the intent of the Federal and State regulations associated with the closure of the CCR surface impoundments. The remainder of the work required to install the new ash handling technology, develop the new lined LVWTS, and develop the new water handling systems for the LRCP is described further in Section 2.3 of this demonstration.

2.1.7 Technical Infeasibility of Obtaining Alternative Capacity prior to April 11, 2021

Based on the foregoing facts, IKEC cannot cease all CCR and non-CCR wastestreams and initiate closure of the WBSP until the boiler slag handling conversion is complete and the new LVWTS is constructed, and the non-CCR wastewater flows are directed to the new lined treatment system. Additionally, IKEC cannot cease non-CCR wastestreams to the LRCP until the offsite stormwater flows are diverted and new landfill runoff/leachate management system is constructed. IKEC began its selected compliance project execution for Clifty Creek Station with scoping studies in 2015 and is in the process of negotiating either an EPC or design-bid-build contract to execute this project. This work is in progress but has not yet been completed. It is not technically feasible to procure the equipment, perform the necessary detailed design, and complete the pre-outage construction activities for each the boiler slag and low-volume wastewater projects and stormwater management systems over the course of the next six months. Consequently, it is not possible to implement the measures discussed above in a manner that would be successful by April 11, 2021.

Thus, the conditions at Clifty Creek Station demonstrate that no alternative disposal capacity is available on-site or off-site, satisfying the requirement of 40 CFR 257.103(f)(1)(i), and IKEC respectfully requests a site-specific extension of the deadline to initiate closure of the CCR surface impoundments until the date on which those actions are expected to be completed.

2.1.8 Justification for Time Needed to Complete Development of Alternative Capacity Approach – § 257.103(f)(1)(iv)(A)(1)(iii)

The schedule for developing alternative disposal capacity is described in more detail in Sections 2.2 and 2.3. The milestones for progress are summarized in Table 2-6, below. IKEC is requesting an alternative site-specific deadline of December 5, 2022 to cease receipt of wastestreams in the WBSP and initiate closure of that facility and a deadline April 25, 2023, to cease receipt of wastestreams in the LRCP and initiate closure of that facility. The primary factor affecting the compliance schedule at the Clifty Creek Station is the ability to manage CCR and non-CCR wastestreams throughout construction in a way that allows the plant to continue to meet the NPDES discharge limits. If IKEC were to consider alternative temporary solutions to allow for the WBSP to be removed from service, such a measure would require the use of approximately 550 frac tanks to provide one day of storage capacity for these flows, not including stormwater contributions. These tanks would require significant site development for containment measures and significant interconnecting piping which would propose an unacceptable amount of potential for leaks. Furthermore, assuming a solids content of 1% in the comingled wastestreams, approximately five of these frac tanks would need to be removed and replaced each day. Instead, IKEC is choosing to bypass the flows around the construction work area so that the south portion of the pond can continue to handle these flows while construction is underway.

Additionally, as described earlier in this section IDEM has indicated to IKEC that they intend to approve the closure activities under their RWS landfill program as a Type I landfill. There is potential for extending the project schedule if IKEC has to work through multiple iterations of the design based on feedback from IDEM. IKEC will progress with activities as allowed by IDEM; however, IKEC must coordinate proposed pond closure work with IDEM and cannot proceed with major construction activities without IDEM approval Proceeding without the required permitting approvals, as well as other various construction activities notifications required by the RWS program, could result in potential violations and enforcement action being brought against IKEC.

At the LRCP, IKEC must divert offsite stormwater around the pond limits in order for the landfill pond work to proceed. Due to the expansive drainage area (over 500 acres) and large variability of these stormwater flows, it is not feasible to capture the flows in frac tanks. Consequently, IKEC believes this requested schedule represents the fastest technically feasible timeframe for compliance at Clifty Creek Station, and these durations are faster than EPA's assessment of the average time required to construct a dry ash handling conversion and a non-CCR basin. For Clifty Creek Station's specific case, these options cannot be completed simultaneously due to site availability and operational constraints as the non-CCR LVWTS are being constructed within the existing footprint of the WBSP and LRCP. IKEC has overlapped these activities as much as feasible.

Table 2-6: Compliance Project Progress Milestones

Year or Progress Reporting Period	Status	Milestone Description	IKEC Notes
2020	Completed	Selection of ash handling solution and preparation of request for alternative site-specific deadline for initiation of closure of the CCR Surface Impoundments.	

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Year or Progress Reporting Period	Status	Milestone Description	IKEC Notes
2020	On Schedule	FEED study and detailed scope development and award EPC or detailed design contracts	
April 30, 2021	Scheduled	BSHS site prep construction package awarded	
October 31, 2021	Scheduled	BSHS/LVWTS equipment procurement packages bid/awarded, BSHS/LVWTS and LRCP construction packages bid/awarded	
April 30, 2022	Scheduled	BSHS site prep construction complete, BSHS/LVWTS and LRCP construction underway with hillside (i.e. offsite stormwater) diversion channel complete	The hillside diversion channel will divert offsite stormwater flows around the west side of the LRCP to the new stormwater outfall.
October 31, 2022	Scheduled	BSHS/LVWTS foundations and equipment in place, BSHS operational	Tie-in outages and startup of LVWTS will be completed by the end of the calendar year. Normal flows of CCR and non-CCR wastewater to the WBSP will cease by December 5, 2022.
April 30, 2023	Scheduled	LVWTS operational, LRCP landfill runoff/leachate management system constructed	Normal flows of CCR and non-CCR wastewater to the LRCP will cease by April 25, 2023. WBSP and LRCP closures are underway as well (those activities are not part of this demonstration).

2.2 Detailed Schedule to Obtain Alternative Disposal Capacity

The required visual timeline representation of the schedule for the activities outlined in Sections 2.1.6 and 2.3 is included in Appendix C of this demonstration.

2.3 Narrative of Schedule and Visual Timeline

As shown in Appendix C and described in Sections 2.1.6 and 2.4, IKEC has already undertaken significant planning steps towards initiating closure of the WBSP and the LRCP. This section of the demonstration is focused on the remaining work necessary to obtain alternative disposal capacity for the CCR and non-CCR wastestreams and initiate CCR surface impoundment closures at the Clifty Creek Station. The durations shown in the schedule in Appendix C are based on a number of factors, including a

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50-hour per week construction schedule, the estimated volume of concrete to be installed for the settling tank, piping quantities for the new concrete settling tank and LVWTS, and the estimated volume of earthwork required.

Contract Negotiation: IKEC is currently working with BMcD to jointly develop the front-end engineering deliverables for the project, develop specifications to procure the major equipment, perform the required geotechnical/survey/pilot trenching/laser scanning/water sampling activities necessary to support design, refine the project scope, and develop a target price to serve as the basis for either a multiple-subcontract Engineer-Procure-Construct (EPC) contract or a design-bid-build contract. These efforts involve completion of approximately 30% of the project design, as well as award of the contract and are expected to be completed in November of 2020. This contracting method has been selected to facilitate completing the project on a timeline that is as soon as technically feasible, consistent with the CCR Rule.

Boiler Slag Handling and WBSP Modifications: Detailed engineering for the boiler slag treatment equipment and LVWTS construction contracts will begin in November of 2020 after EPC or design-bid-build contract is awarded and this work is scheduled to be completed in December of 2021 following release of the electrical construction contract for bid. The design will be grouped into multiple work packages and construction subcontracts to facilitate the required construction sequence. These work packages include the site preparation efforts, pond closure, concrete settling tank (i.e. BSHS), and mechanical/electrical construction for the ash transport water recycle system and LVWTS (and associated chemical feed system). Permitting through the IDEM will include securing modifications to the NPDES permit and securing Permits-to Install for the concrete settling tank and the LVWTS (and associated non-CCR wastestream piping reroutes, chemical feed systems, and WBSP closure). Six months of permitting time were included (note this covers both the boiler slag conversion and pond modification scope) and will coincide in part with the end of the detailed engineering for each required phase. These permit modifications must be completed before the associated construction of the BSHS concrete settling tank, WBSP Closure and the new LVWTS construction is initiated. While IKEC is currently reflecting an anticipated permitting timeframe of six months to secure permitting required to initiate closure, its experience has been that permitting associated with CCR units is not normally secured within the six-month timeframe indicated in Indiana regulations. Permitting timeframes have been closer to 12 months, and at times longer, to secure permits associated with CCR units in Indiana. IKEC is committed to working with IDEM to expedite project permitting in support of the timeline proposed herein but may experience project schedule impacts as a result in a delay in receiving required permits.

Preparation of equipment specifications for the pumps, chem feed system, overflow hoppers, and electrical equipment will occur concurrently with detailed engineering beginning in the November of 2020. The electrical equipment (PCM and associated transformers) is the only long-lead item provided in the schedule, and the remaining equipment procurement activities will be completed concurrent with this duration. The civil construction contract will include site preparation, dewatering the portion of the WBSP in the vicinity of the BSHS and LVWTS, installing piling and/or performing consolidation of subgrade soils (to be determined during ongoing geotechnical investigation), construction of the concrete settling tank, construction of the LVWTS, and closure of the CCR surface impoundments. This will likely be divided into two contract scopes to support construction of the concrete settling tank and redirection of the sluice flows concurrent with the required permitting efforts for the pond closure and LVWTS construction, with the goal of the EPC contractor (or the design-bid-build engineer) to accelerate this effort as much as possible. The mechanical/electrical scope will include installation of the major utility corridors (i.e. piping to/from the concrete settling tank and LVWTS), construction of the PCM at the concrete settling tank, installation of the new recycle pumps, installation of new raceway/cable to power the new equipment, and completion of balance of plant scope as required for the project.

The concrete settling tank construction will require close coordination between plant operations and the contractor. This work will proceed in the following order once construction is underway:

- The contractor will divert stormwater flows around the construction area.
- The contractor will reroute the WBSP influent flows around the BSHS and LVWTS construction area to the south. The contractor will dewater the north portion of the WBSP and place CCR material within the footprint of the concrete settling tank as required to support preparation of the subgrade. This area requires pre-loading (i.e. surcharge loading) to consolidate the CCR material and subgrade soils in the area. This activity must occur after the sluice flow is rerouted
    - The schedule duration is based on the contractor placing approximately 140,000 cubic yards (CY) of CCR material as part of the surcharge loading effort. After the surcharge material is placed, it will remain for 40-50 working days (approximately two months).
- The contractor will excavate approximately 75,000 CY of surcharge material as required to support the new concrete settling tank foundation construction.
- The contractor will construct the concrete settling tank and recycle tank floor and walls along with supporting system foundations. The construction duration shown in Appendix B is based on an estimated 75,000 labor hours for the 9,100 CY of concrete (and associated rebar) required for the project and is based on a crew working 50 hours per week. This work cannot start until the

Permit-to-Install is received for the BSHS. During this time the contractor will also install the PCM, transformer, and the chemical feed system foundations.

- The contractor will backfill the settling tank after the walls are complete. This activity is anticipated to take a month to complete. Following this effort, the contractor will install, the stackout area slab. The phasing of this work is anticipated to take approximately six weeks of construction.
- After the foundations are completed and the mechanical construction contract is awarded, the contractor will install the PDC, transformers, and necessary mechanical equipment. This will include installation of the new pumps, chemical feed equipment, piping, and balance of plant items necessary to support recycling the boiler slag ash transport water system. The mechanical construction duration is based on an estimated 70,600 labor hours for the equipment installation and 28,800 feet of piping required for the project and is based on a crew working 50 hours per week. The piping installation will begin before the slag tank construction is completed, but the equipment erection and piping will not be able to complete until approximately two months after the tank walls are completed.
- The electrical construction will be performed concurrently, albeit slightly lagged to the mechanical construction. The electrical construction duration is based on an estimated 29,700 labor hours for the 6,600 feet of raceway and 238,600 feet of cable (and associated terminations) required for the project and is based on a crew working 50 hours per week. This work will be completed at least two months after the PCM and transformers are set in place to allow for terminations at those locations.
- The BSHS equipment startup and commissioning will take place over ten weeks following completion of the mechanical and electrical BSHS construction but prior to finishing LVWTS construction. This allows for sequential integration of Units 1-6 to transfer from wet to high recycle system handling. At this point, the sluicing of boiler slag to the WBSP will cease, and the high recycle rate system will be used for future handling of boiler slag at the Clifty Creek Station.
- During construction of the BSHS, the Contractor will proceed with construction of the LVWTS, including re-grading the area and installing a composite liner system, slope protection, and new pond outlet structure. CCR material removed from the LVWTS footprint will be used to regrade the pond closure area, including around the concrete settling tank area. These construction activities cannot proceed until IDEM approves the design and provides the permit to install these facilities:
    - The contractor will clear and grub the areas within the pond to be graded and install stormwater diversion channels to reroute flow around the work areas.

  - The contractor will re-grade approximately 350,000 CY of material within the Phase 3 construction area (includes the LVWTS footprint). This schedule assumes that the CCR material will not need to be double handled prior to compacting in place.
  - The composite liner system will likely consist of a geosynthetic clay liner, 60-mil high-density polyethylene geomembrane, geotextile, and 12-inches of suitable fill material. Preliminary liner details are provided in Appendix D. Additionally, 18-inches of riprap will be placed on the pond slopes and a minimum of 6-inches of concrete will be placed over the bottom of the primary basin to facilitate cleanout. Installation of the liner system components is planned to overlap as much as possible and finish two months after the grading operations.
- The contractor will install piping to reroute the non-CCR wastestreams to the LVWTS. This activity will happen concurrently with the BSHS construction, and the tie-points (tees and valves) will be installed as necessary during prior outages so that once the pond construction and NPDES permit modifications are completed, the flows to the new LVWTS can be initiated.
- Ditches will be graded within the WBSP closure area to convey flows from the LVWTS and portions of the closed pond to a new outfall structure. The ditches will be lined with a CCR Rule compliant cover system. This work will happen concurrently with the LVWTS and outfall construction as shown in the schedule.
- Startup and commissioning of new LVWTS is expected to take four weeks to optimize the chemical feed systems and cease use of the WBSP for non-CCR wastestreams. Startup cannot commence until the liner system is installed and accepted by IDEM. In addition, the mechanical and electrical construction scopes will also need to be completed.

LRCP Pond Modifications: Detailed engineering for the LRCP modifications will be performed concurrently with the BSHS/WBSP Modifications. The design will be grouped into work packages as needed to meet the compliance deadlines. The work packages include:

- Grading in a new stormwater ditch to divert offsite runoff around the LRCP to a new stormwater outfall south of the LRCP (approximately 140,000 CY of cut/fill).
- Dredging material from the proposed footprint of the new lined leachate and stormwater treatment systems (approximately 190,000 CY).
- Installing a new berm (approximately 69,000 CY of cut/fill) for the west leachate collection pond upstream of the leachate and stormwater treatments systems. The collection pond (5.8 acres) will accept landfill flows during construction of the treatment systems and will receive a composite liner system consisting of a geosynthetic drainage layer, GCL, flexible membrane liner,

geotextile, and 12-inch protective cover layer. The collection pond will eventually overflow to the treatment pond.

- Installing a new berm (approximately 60,000 CY of cut/fill) within the footprint of the dredged area for the sediment pond. The sediment pond (6.6 acres) will also receive a composite liner system as described for the leachate collection pond. The sediment pond will overflow to a ditch, which will tie into Outfall 001. The ditch will be constructed in the LRCP closure area and capped with the LRCP cover system.
- Installing a new berm (approximately 28,000 CY of cut/fill) within the footprint of the dredged area for the leachate treatment pond. The treatment pond (2.1 acres) will overflow to the sediment pond and will also receive a composite liner system.
- Installing a new leachate collection pond (2.0 acres) on the east side of the landfill. The new perimeter berm will require approximately 18,000 CY of cut/fill and will also receive a composite liner system. The east leachate collection pond will have the capability to overflow via an internal outfall to stormwater ditches which will be incorporated into the WBSP closure design.

Once the landfill ponds are in place the remaining LRCP area may be closed. IKEC will continue to work toward manners in which it can expedite the ultimate closure of the LRCP and provide regular updates per the requirement of the CCR Rule.

2.4 Progress Narrative Toward Obtaining Alternative Capacity

In the preamble to the final Part A rule, EPA explains that this "section [of the workplan] must discuss all of the steps taken, starting from when the owner or operator initiated the design phase all the way up to the current steps occurring while the workplan is being drafted." 85 Fed. Reg. at 53,544. The discussion also must indicate where the facility currently is on the timeline and the processes that are currently being undertaken at the facility to develop alternative capacity. 85 Fed. Reg. at 53,545.

As described in Section 2.1.6 and as shown in Appendix C, IKEC has made considerable progress in developing a path forward for obtaining alternative disposal capacity for the CCR and non-CCR wastestreams at the Clifty Creek Station that are currently managed in the WBSP and LRCP. IKEC, Stantec, and BMcD have gone through multiple iterations of the project scoping and cost estimate development in order to find the best compliance solution for the plant. BMcD and IKEC have completed the project scoping and cost estimate development efforts, have selected the preferred compliance solution for the plant, and are finalizing the contracting approach. Water sampling efforts and preliminary design has been completed for the BSHS, laser scans have been completed in the boiler areas, and the BSHS geotechnical investigation has been completed. IKEC did not have a CCR closure trigger for the

WBSP, which is an eligible unlined CCR surface impoundment, prior to the release of the updated CCR Rule (*A Holistic Approach to Closure Part A: Deadline To Initiate Closure)*, which was proposed (pre-published) on November 4, 2019, and finalized by EPA on August 28, 2020.

The LRCP has experienced a statistically significant level above a groundwater protection standard for Appendix IV parameters. As a result, an assessment of corrective measures was completed, which identified the most feasible corrective measures for the unit, but also identified additional field work that was needed to better understand site conditions prior to selecting and subsequently implementing the appropriate corrective measure. That field work continues, and includes:

1. Conducting additional characterization of the groundwater near the LRCP through a more expansive monitoring scheme. Additional groundwater monitoring wells were installed at the IKEC property line to determine if groundwater leaving the IKEC site exhibited similar concentrations of CCR groundwater parameters to the wells observed to be exceeding GWPS. To date, none of the wells at the IKEC property line have been found to exhibit similar concentrations of the CCR parameters.
2. Continuing to collect groundwater elevation information at various points across the site to help better understand the groundwater dynamics near the unit.
3. Assessing manners in which to effectively manage stormwater run-on from property not owned by IKEC to support redirecting stormwater away from the unit.
4. Collecting additional geotechnical data to further define the unit's subsurface characteristics. IKEC is reflecting that progress in semiannual Remedy Selection Progress Reports, which will be updated in December 2020.

Separately, IKEC determined it was appropriate to pause before executing its CCR/ELG compliance strategy prior to learning how the continued development of those rules could ultimately impact that strategy. For example, revisions being made to the bottom ash transport water requirements in the ELG rule were anticipated to impact the manner in which IKEC would manage its operation once the rule was issued final. It is imperative given the physical constraints of the facility that IKEC's CCR Rule compliance strategy, which will result in numerous plant modifications, would also enable the plant to meet the requirements of the revised ELG rule (85 Fed. Reg. 64,650 (October 13, 2020).

3.0 DOCUMENTATION AND CERTIFICATION OF COMPLIANCE

To demonstrate that the criteria in 40 C.F.R. § 257.103(f)(1)(iii) has been met, the following information and submissions are submitted pursuant to 40 C.F.R. § 257.103(f)(1)(iv)(B) to demonstrate that the CCR surface impoundments are in compliance with the CCR Rule.

3.1 Owner's Certification of Compliance

In accordance with 40 CFR § 257.103(f)(1)(i)(C), I hereby certify that, based on my inquiry of those persons who are immediately responsible for compliance with environmental regulations for the Clifty Creek Station, the CCR surface impoundments are in compliance with all of the requirements contained in 40 CFR §257 Subpart D – Standards for the Disposal of Coal Combustion Residuals in Landfills and Surface Impoundments. Clifty Creek's CCR compliance website is up-to-date and contains all the necessary documentation and notification postings.

INDIANA-KENTUCKY ELECTRIC CORPORATION

J. Michael Brown

J. Michael Brown
Environmental, Safety & Health Director
November 17, 2020

3.2 Visual Representation of Hydrogeologic Information - § 257.103(f)(1)(iv)(B)(2)

Consistent with the requirements of § 257.103(f)(1)(iv)(B)(2)(i) – (iii), IKEC has attached the following items to this demonstration:

- Map(s) of groundwater monitoring well locations in relation to the CCR unit (Appendix E1 – see Figures 8-10)
- Well construction diagrams and drilling logs for all groundwater monitoring wells (Appendix E1 – see Appendix B)
- Maps that characterize the direction of groundwater flow accounting for seasonal variations (Appendix E2)

3.3 Groundwater Monitoring Results - § 257.103(f)(1)(iv)(B)(3)

The groundwater monitoring data through the first 2020 semi-annual sampling event is summarized in the table included as Appendix E3.

3.4 Description of Site Hydrogeology - § 257.103(f)(1)(iv)(B)(4)

Appendix D1 includes a description of the site hydrogeology (see Section 3.0) and stratigraphic cross-sections of the site are included as Appendix E4.

3.5 Corrective Measures Assessment - § 257.103(f)(1)(iv)(B)(5)

Background sampling for the WBSP and LRCP occurred between January of 2016 and August of 2017 with nine independent samples collected. The first semiannual detection monitoring samples were collected in March of 2018. The WBSP remains in detection monitoring. Based on the results of the ongoing groundwater monitoring program, an assessment of corrective measures is not currently required for the WBSP.

For the LRCP, the first assessment monitoring samples were collected in October of 2018. Statistically significant levels were confirmed for Boron and Molybdenum in wells CF-15-08 and CF-15-09. During the 2019 groundwater sampling and analysis it was confirmed that Boron levels exceeded the GWPS in wells CF-15-08 and CF-15-09 and Molybdenum exceeded the GWPS in well CF-15-08. An assessment of corrective measures was completed in September of 2019 and is included as Appendix E5.

3.6 Remedy Selection Progress Report - § 257.103(f)(1)(iv)(B)(6)

As noted above, an assessment of corrective measures and resulting remedy selection efforts are not currently required for the WBSP. The remedy selection progress report for the LRCP is included as Appendix E6.

3.7 Structural Stability Assessment - § 257.103(f)(1)(iv)(B)(7)

Pursuant to § 257.73(d), the initial structural stability assessment report for the CCR surface impoundments was prepared in October 2016 and is included as Appendix E7. As required for compliance, another stability assessment will be completed in October 2021.

3.8 Safety Factor Assessment - § 257.103(f)(1)(iv)(B)(8)

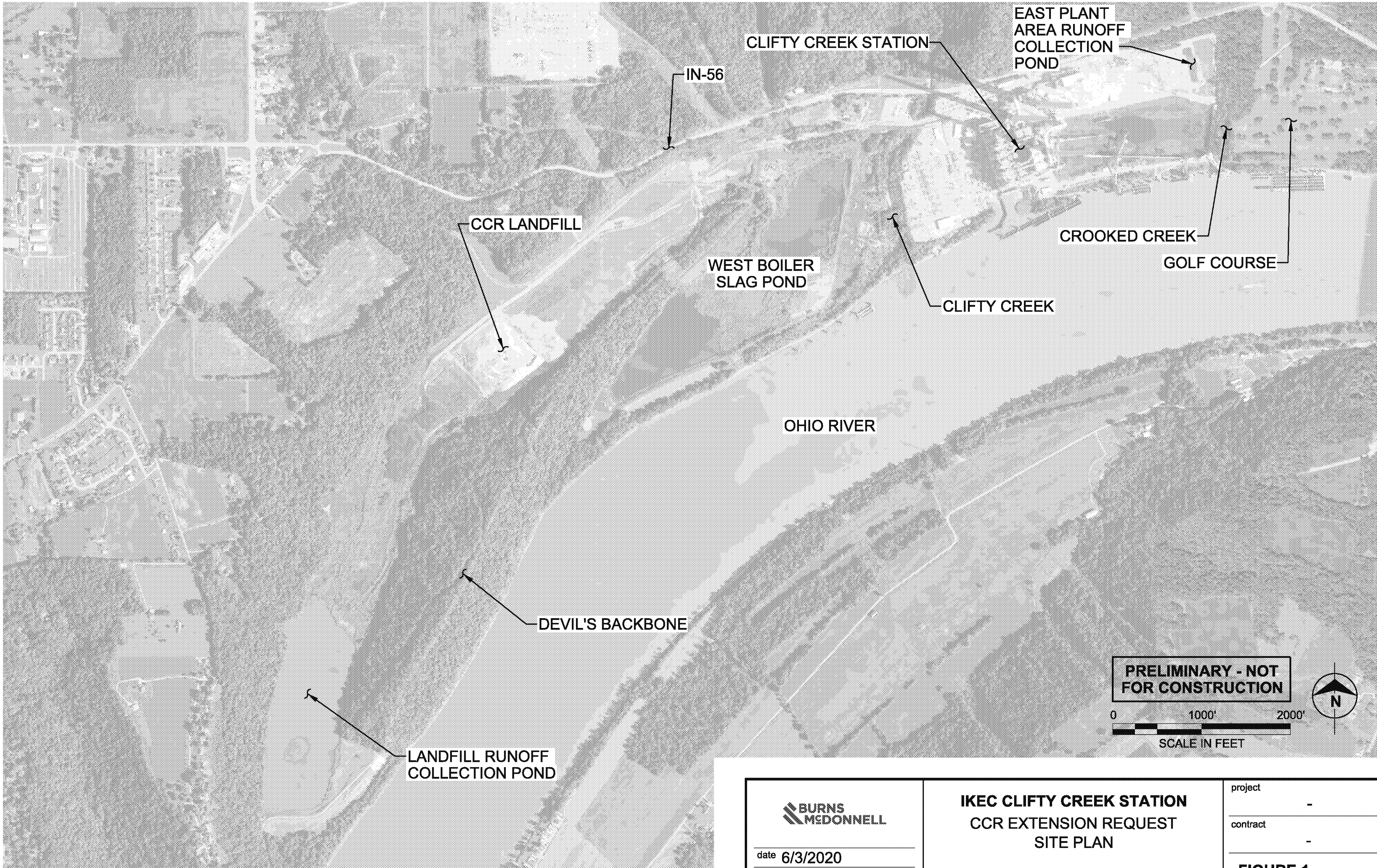
Pursuant to § 257.73(e), the initial safety factor assessment report for the CCR surface impoundments was prepared in October 2016 and is included as Appendix E8. As required for compliance, another stability assessment will be completed in October 2021.

4.0 CONCLUSION

Based upon the information submitted in this demonstration, IKEC has demonstrated that the WBSP and LRCP at the Clifty Creek Station qualify for a site-specific alternative deadline for the initiation of closure as allowed by 40 CFR §257.103(f)(1).

Therefore, IKEC requests that EPA approve this demonstration, thereby granting the alternative deadline of December 5, 2022, to cease routing all CCR and non-CCR wastestreams to the WBSP and April 25, 2023, to cease routing all CCR and non-CCR wastestreams to the LRCP and initiate closure of these CCR surface impoundments. Following approval of this demonstration, IKEC will update the closure plan for the impoundments to further reflect the schedule and the methods identified herein. There are several variables that could impact the construction of the concrete settling tank, the new lined LVWTS, the new landfill runoff/leachate management system and the initiation of closure of the CCR surface impoundments, including delays in re-grading efforts associated with weather, contractor efficiency, the actual total volume of earthwork to be completed, and delays in securing any applicable state or federal permits. IKEC will update EPA on the project and any potential schedule impacts as part of the semi-annual progress reports required at 40 CFR § 257.103(f)(1)(x), and if a need for a later compliance deadline is determined, IKEC will seek additional time as described in 40 CFR § 257.103(f)(1)(vii).

APPENDIX A – SITE PLANS AND PRELIMINARY DESIGN FIGURES



BURNS McDONNELL

date 6/3/2020

designed A. MYERS

IKEC CLIFTY CREEK STATION

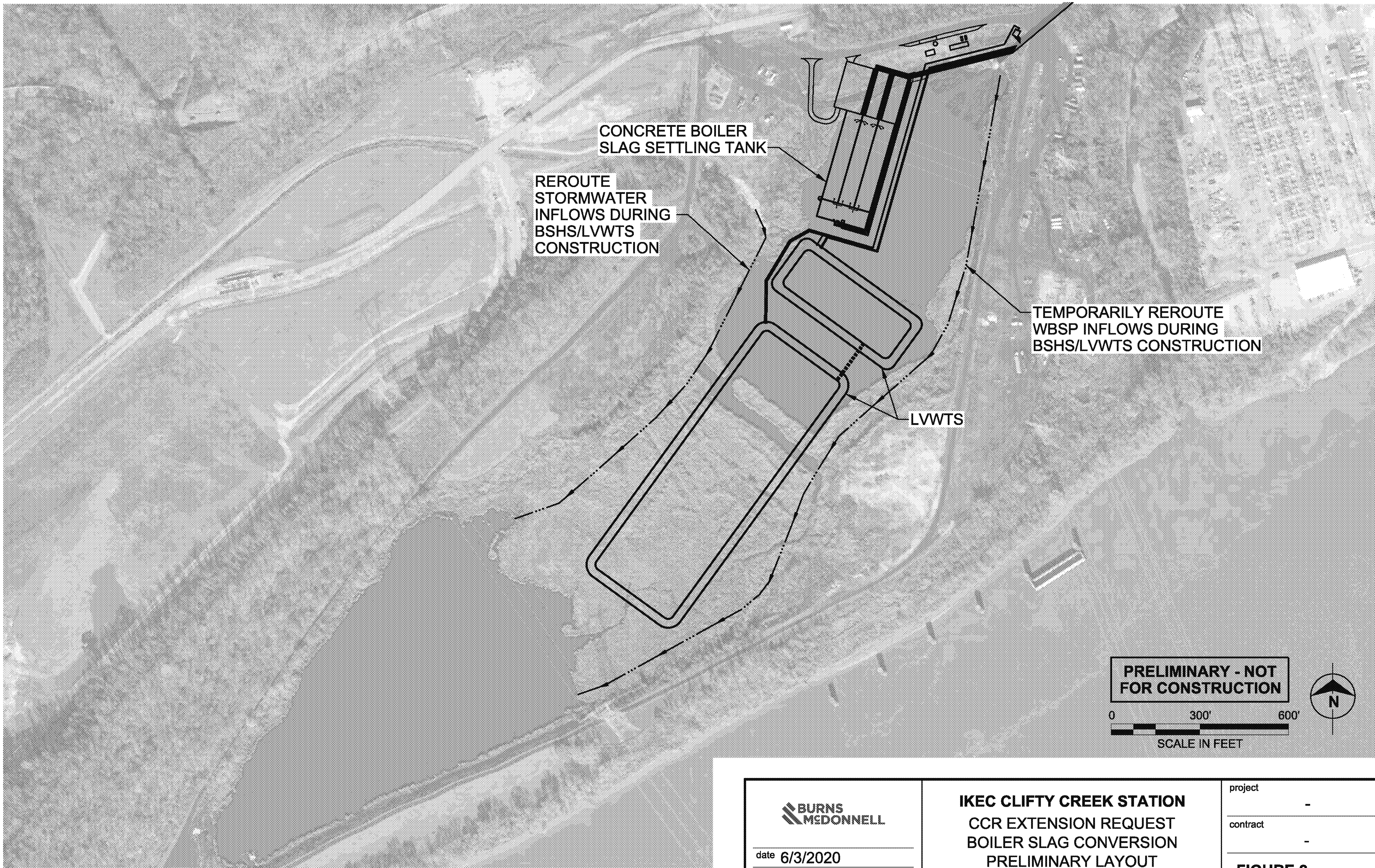
CCR EXTENSION REQUEST

SITE PLAN

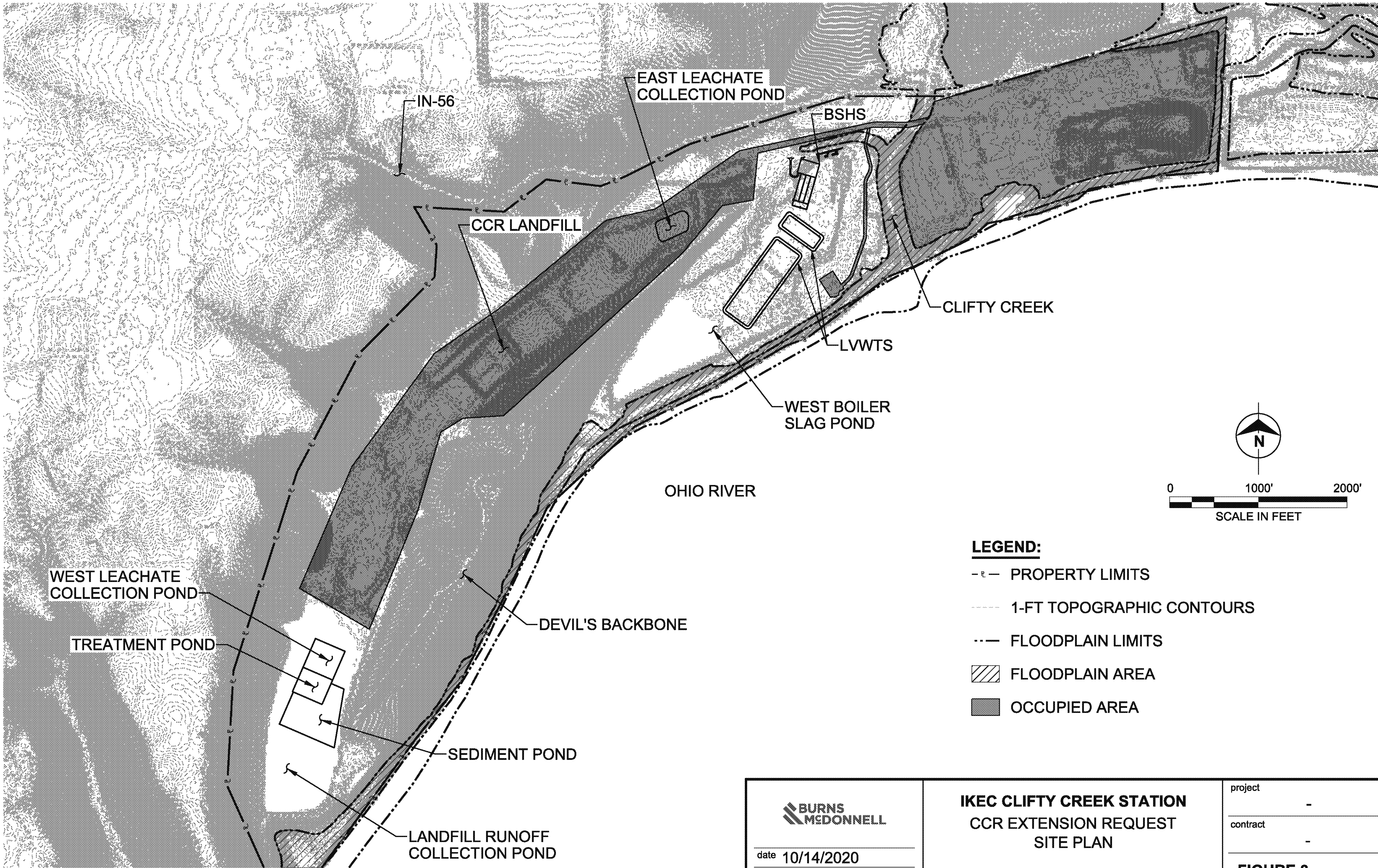
project -

contract -

FIGURE 1



BURNS McDONNELL date 6/3/2020 designed A. MYERS	**IKEC CLIFTY CREEK STATION** CCR EXTENSION REQUEST BOILER SLAG CONVERSION PRELIMINARY LAYOUT	project - contract - **FIGURE 2**



BURNS McDONNELL

date 10/14/2020

designed A. MYERS

IKEC CLIFTY CREEK STATION

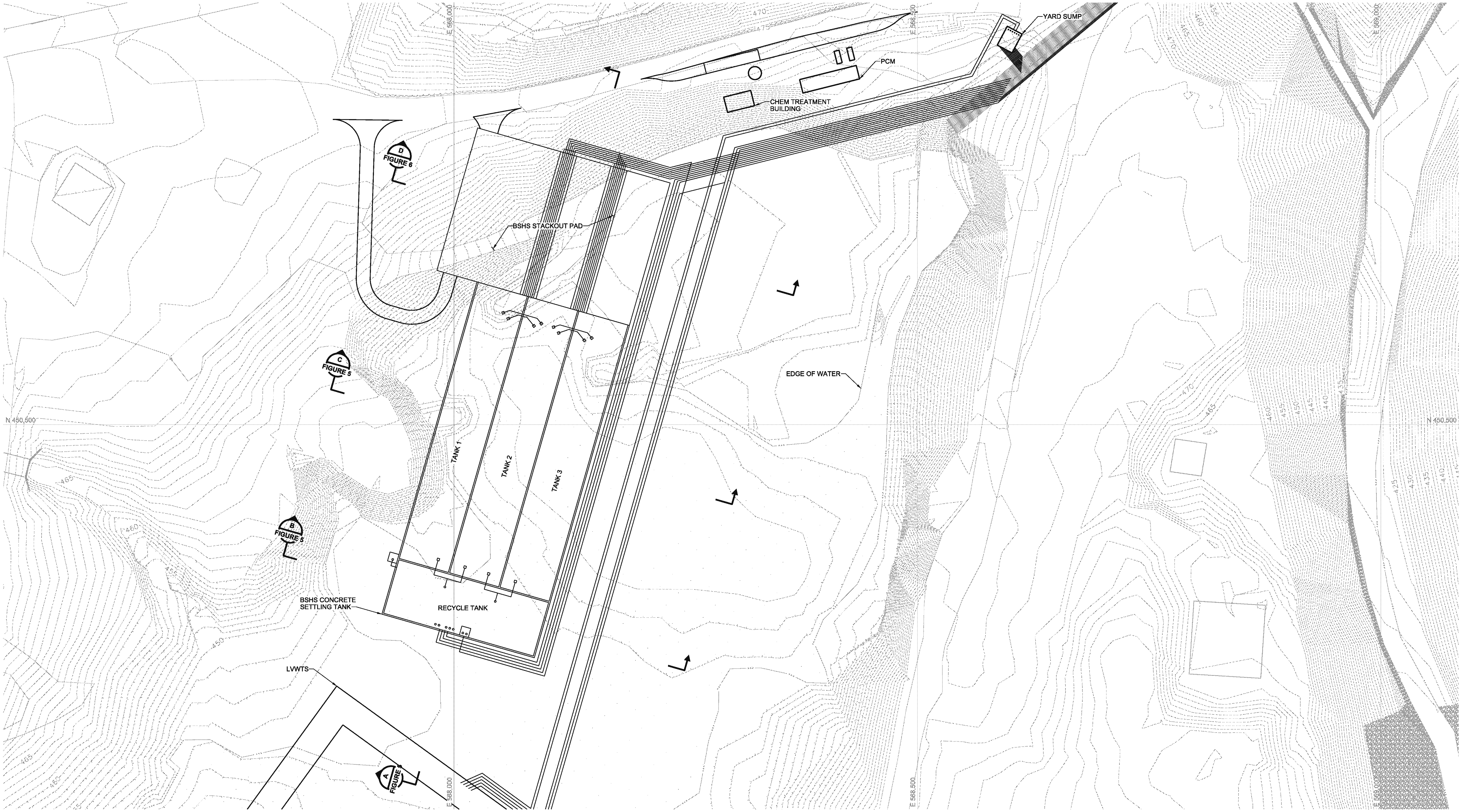
CCR EXTENSION REQUEST

SITE PLAN

project -

contract -

FIGURE 3



NOTES:

1. AREA ADJACENT TO BSHS WITHIN THE WBSP LIMITS WILL BE BACKFILLED AND GRADED TO SUPPORT FINAL CLOSURE OF THE WBSP.
2. DASHED CONTOURS REPRESENT EXISTING (I.E. CURRENT) GRADE BASED ON TOPOGRAPHIC/BATHYMETRIC SURVEY PROVIDED BY HREZO ENGINEERING ON OCTOBER 9, 2020.

NORTH

0 40' 80'
SCALE IN FEET

PRELIMINARY - NOT FOR CONSTRUCTION

no.	date	by	ckd	description
A	11/06/20	AMM	---	FOR INFORMATION ONLY

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9400 WARD PARKWAY
KANSAS CITY, MO 64114
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designed A. MYERS
detailed A. MYERS

OVEC IKEC
Ohio Valley Electric Corporation / Indiana-Kentucky Electric Corporation

JEFFERSON COUNTY, INDIANA

IKEC CLIFTY CREEK STATION
BSHS PLAN

project 125241
contract -
drawing FIGURE 4
rev. A
sheet of sheets
file FIGURE 4.dgn

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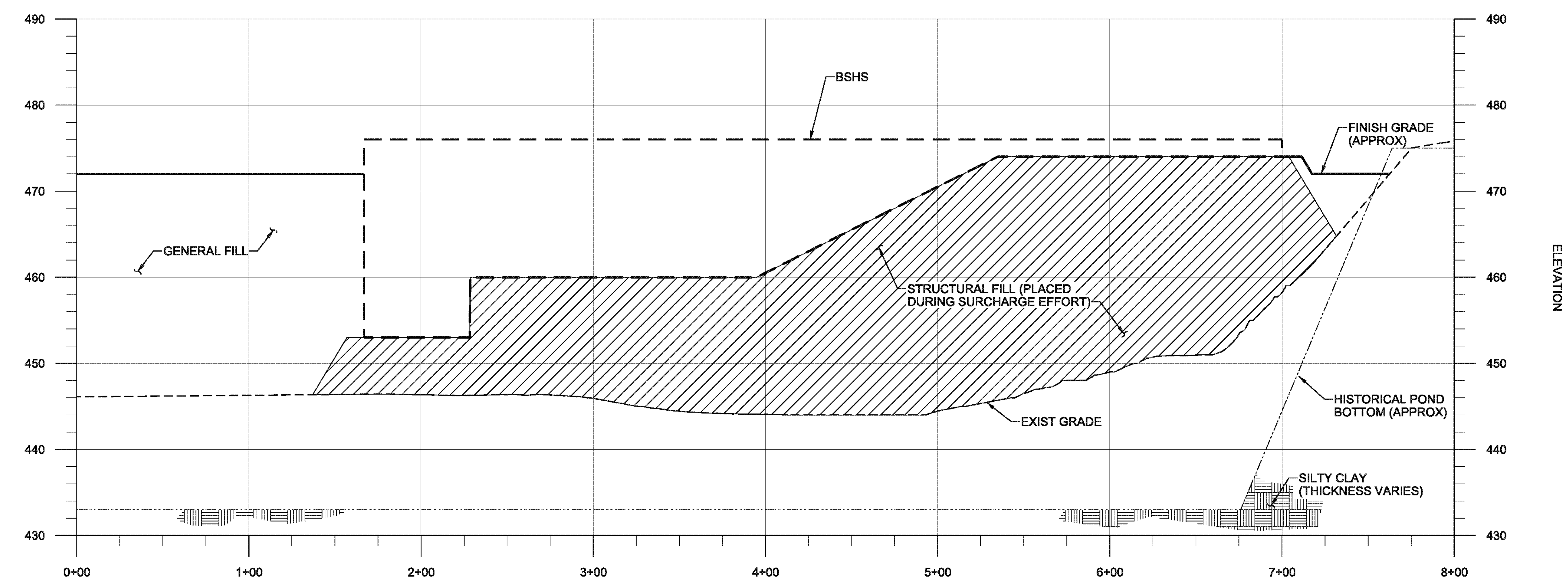
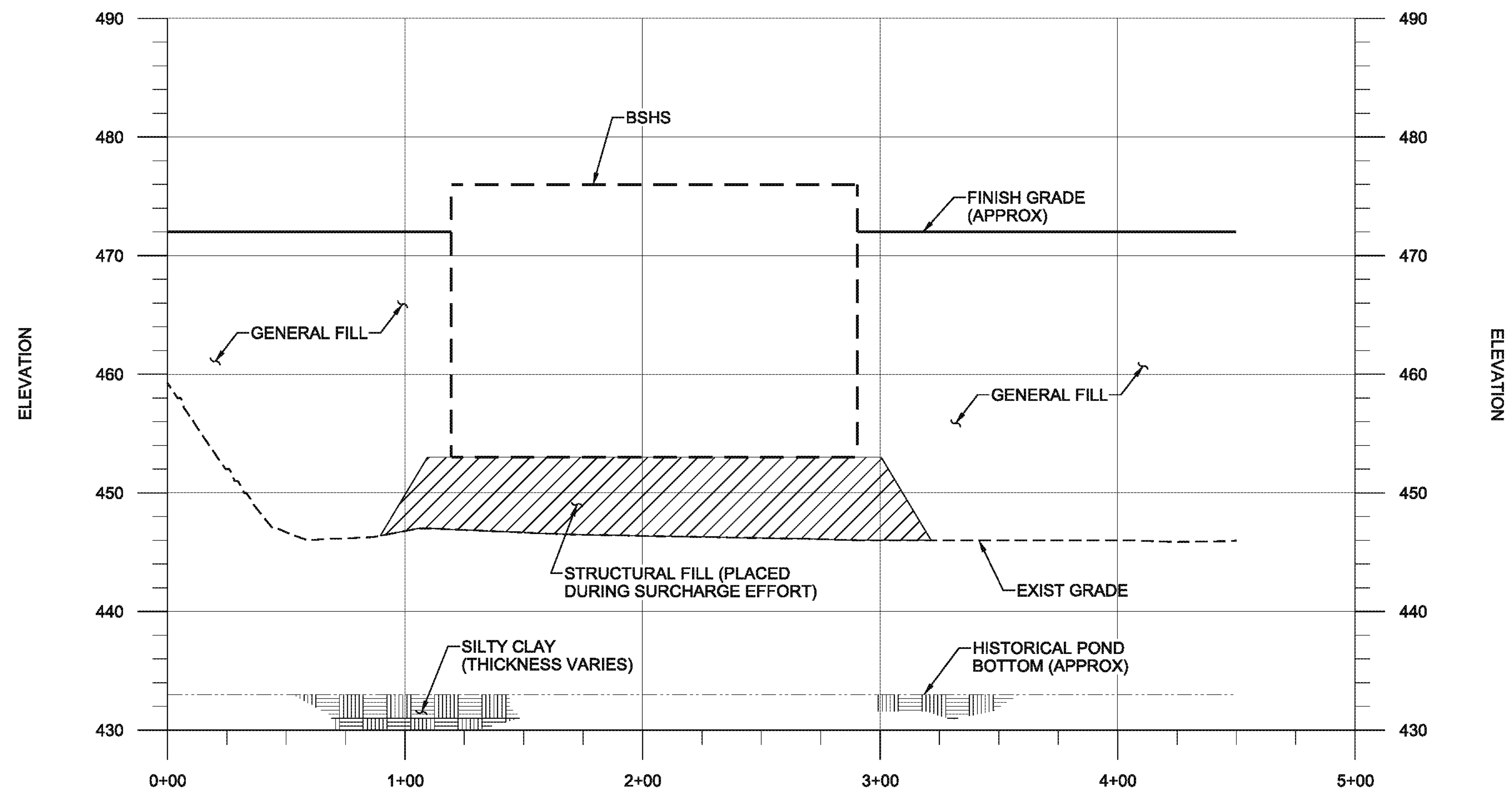
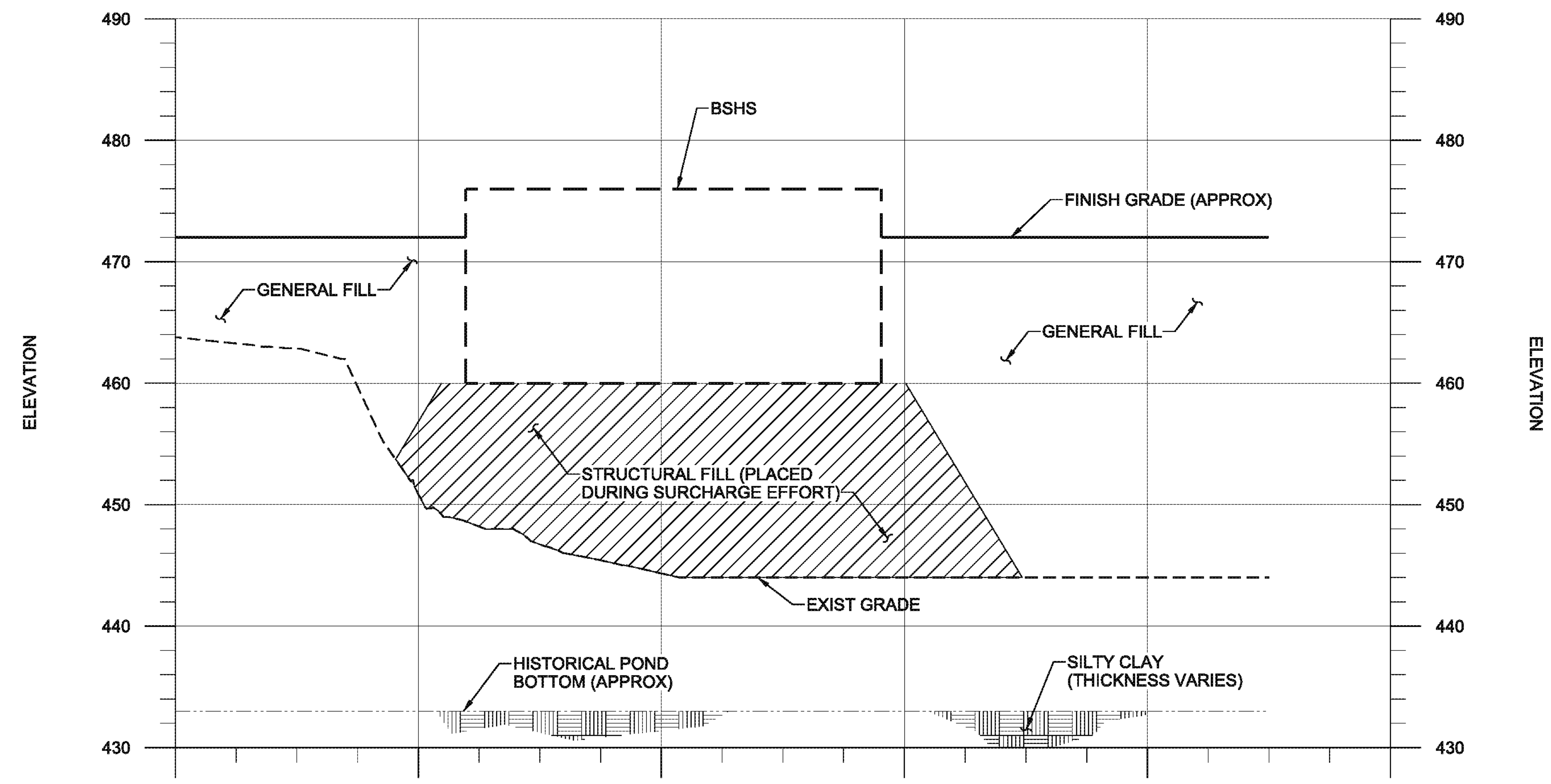


SECTION A FIGURE 4
TO



SECTION B FIGURE 4



SECTION C FIGURE 4

NOTES:

1. FINISH GRADE TO BE DETERMINED BY STANTEC. AREA ADJACENT TO BSHS WITHIN THE WBSP LIMITS WILL BE BACKFILLED AND GRADED TO SUPPORT FINAL CLOSURE OF THE WBSP.
2. EXIST GRADE BASED ON TOPOGRAPHIC/BATHYMETRIC SURVEY PROVIDED BY HREZO ENGINEERING ON OCTOBER 9, 2020.
3. POND BOTTOM APPROXIMATED BASED ON DESIGN GRADING DRAWINGS FROM THE CLIFTY CREEK WBSP HISTORY OF CONSTRUCTION.

HORIZONTAL: 0 40' 80' SCALE IN FEET
VERTICAL: 0 8' 16' SCALE IN FEET

PRELIMINARY - NOT FOR CONSTRUCTION

no.	date	by	ckd	description
A	11/06/20	AMM	---	FOR INFORMATION ONLY

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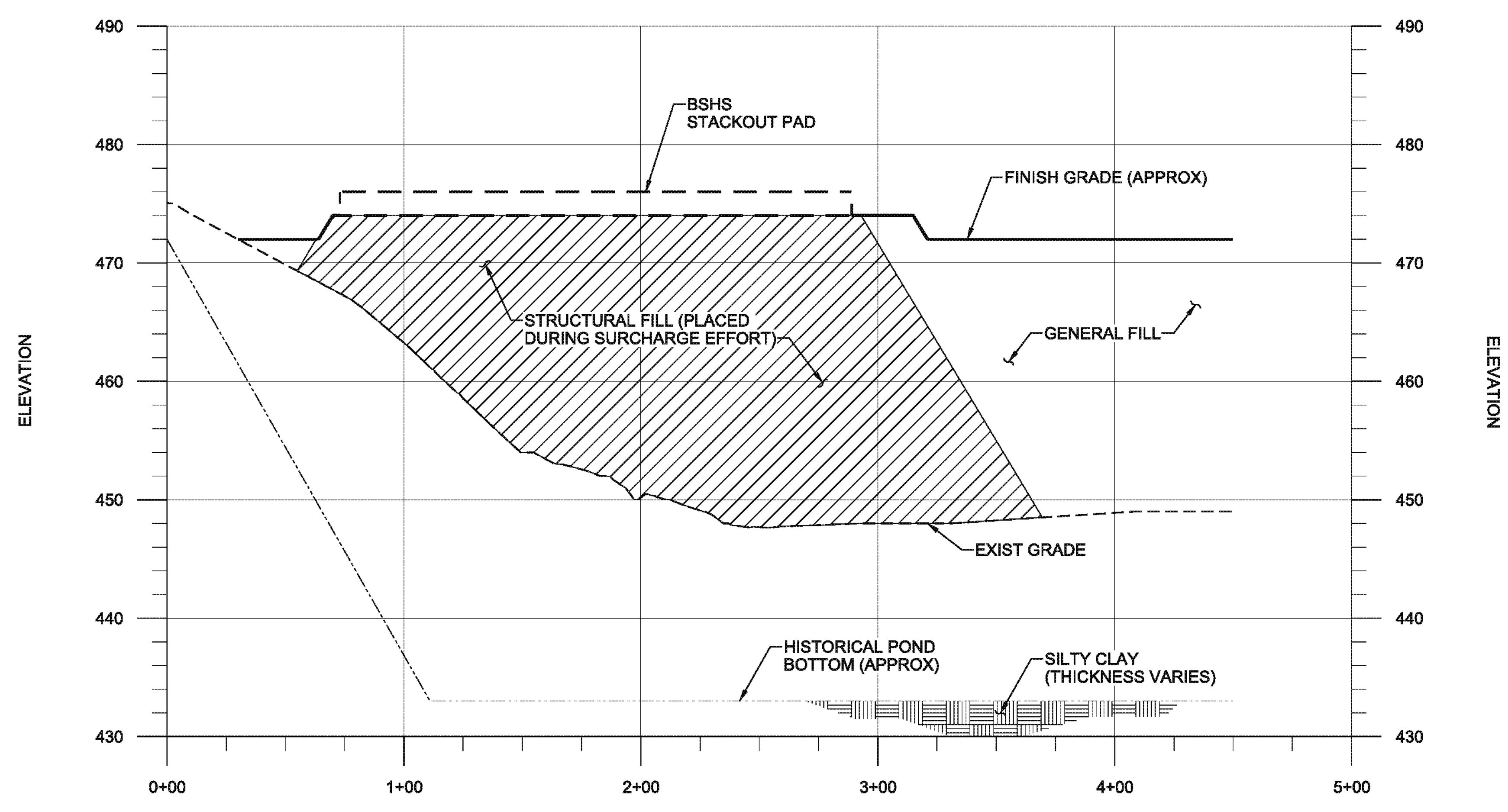
Ohio Valley Electric Corporation / Indiana-Kentucky Electric Corporation
JEFFERSON COUNTY, INDIANA

IKEC CLIFTY CREEK STATION
BSHS CROSS SECTIONS
SHEET 1

project 125241
contract -
drawing **FIGURE 5**
rev. **A**
sheet of sheets
file FIGURE 5.dgn



SECTION D FIGURE 4

NOTES:

1. FINISH GRADE TO BE DETERMINED BY STANTEC. AREA ADJACENT TO BSHS WITHIN THE WBSP LIMITS WILL BE BACKFILLED AND GRADED TO SUPPORT FINAL CLOSURE OF THE WBSP.
2. EXIST GRADE BASED ON TOPOGRAPHIC/BATHYMETRIC SURVEY PROVIDED BY HREZO ENGINEERING ON OCTOBER 9, 2020.
3. POND BOTTOM APPROXIMATED BASED ON DESIGN GRADING DRAWINGS FROM THE CLIFTY CREEK WBSP HISTORY OF CONSTRUCTION.

HORIZONTAL: 0 40' 80' SCALE IN FEET

VERTICAL: 0 8' 16' SCALE IN FEET

PRELIMINARY - NOT FOR CONSTRUCTION

no.	date	by	ckd	description
A	11/06/20	AMM	---	FOR INFORMATION ONLY

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JEFFERSON COUNTY, INDIANA

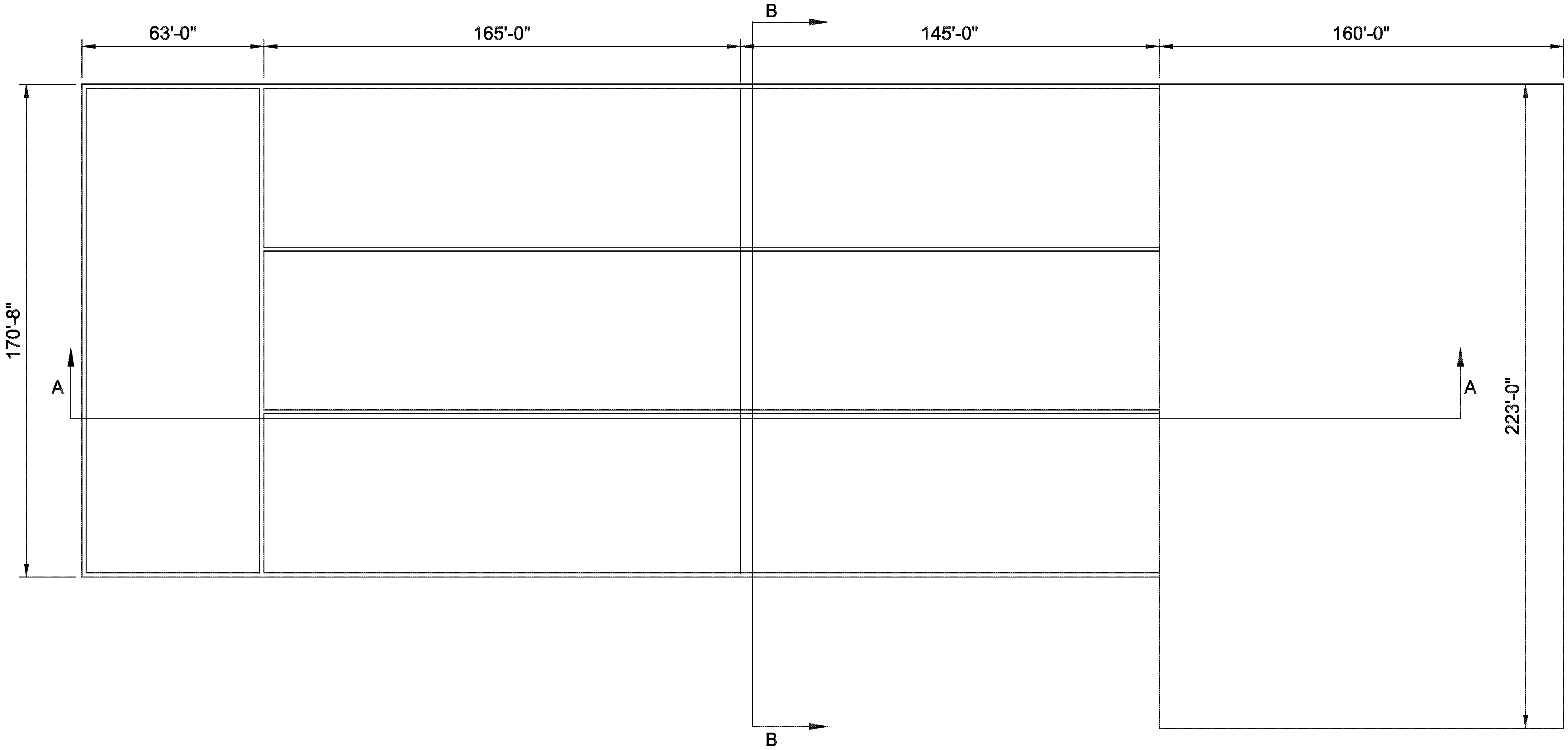
IKEC CLIFTY CREEK STATION
BSHS CROSS SECTIONS
SHEET 2

project 125241 | contract -

drawing **FIGURE 6** | rev. **A**

sheet of sheets

file FIGURE 6.dgn



BURNS McDONNELL

date 10/30/2020

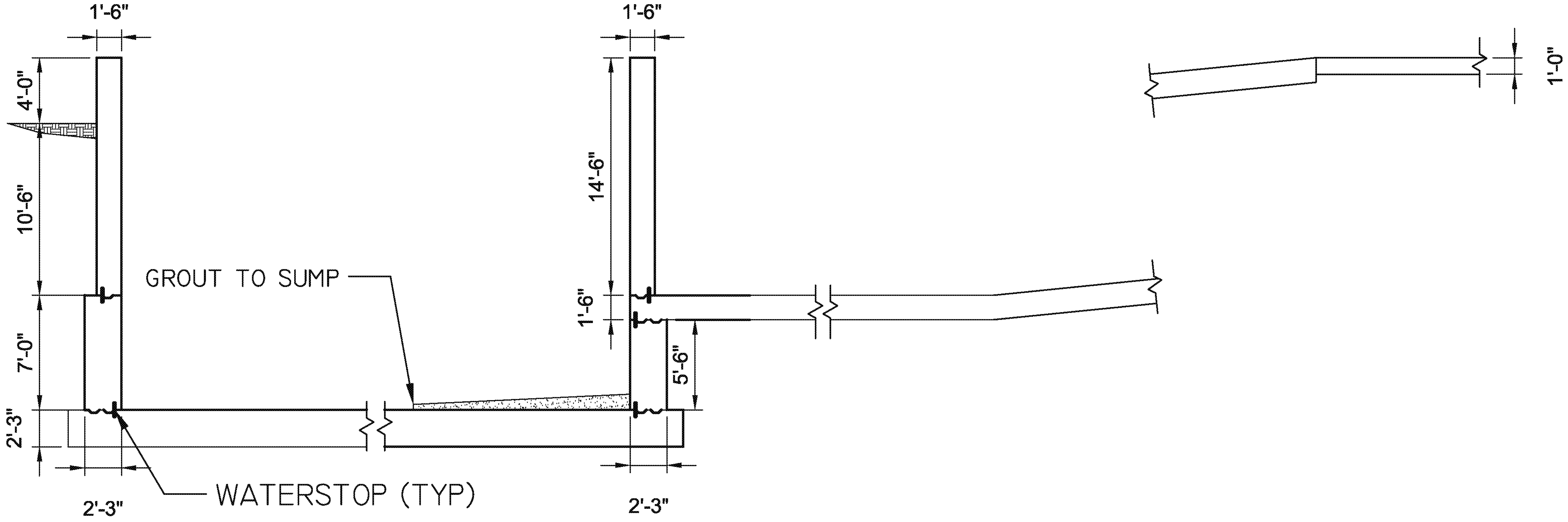
designed R. MAESTRI

CLIFTY CREEK GENERATING STATION
RECYCLE AND SETTLING TANKS
PLAN VIEW

project 125241

contract

SK - S001



BURNS McDONNELL

date 10/30/2020

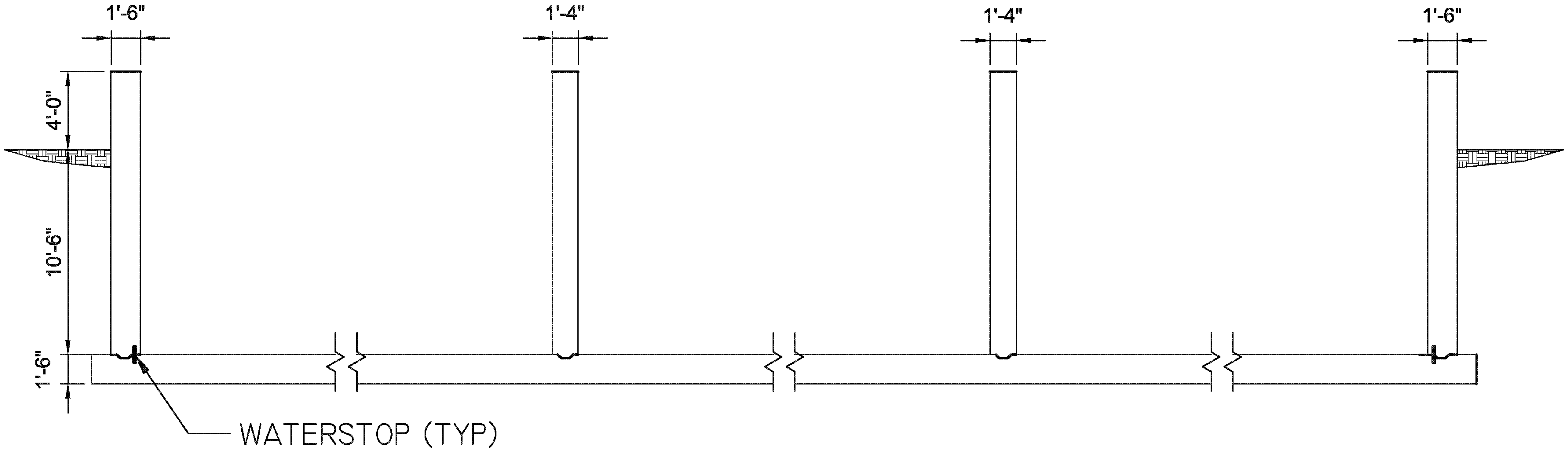
designed R. MAESTRI

CLIFTY CREEK GENERATING STATION
RECYCLE AND SETTLING TANKS
SECTION A

project 125241

contract

SK - S002



BURNS McDONNELL

date 10/30/2020

designed R. MAESTRI

CLIFTY CREEK GENERATING STATION
RECYCLE AND SETTLING TANKS
SECTION B

project 125241

contract

SK - S003

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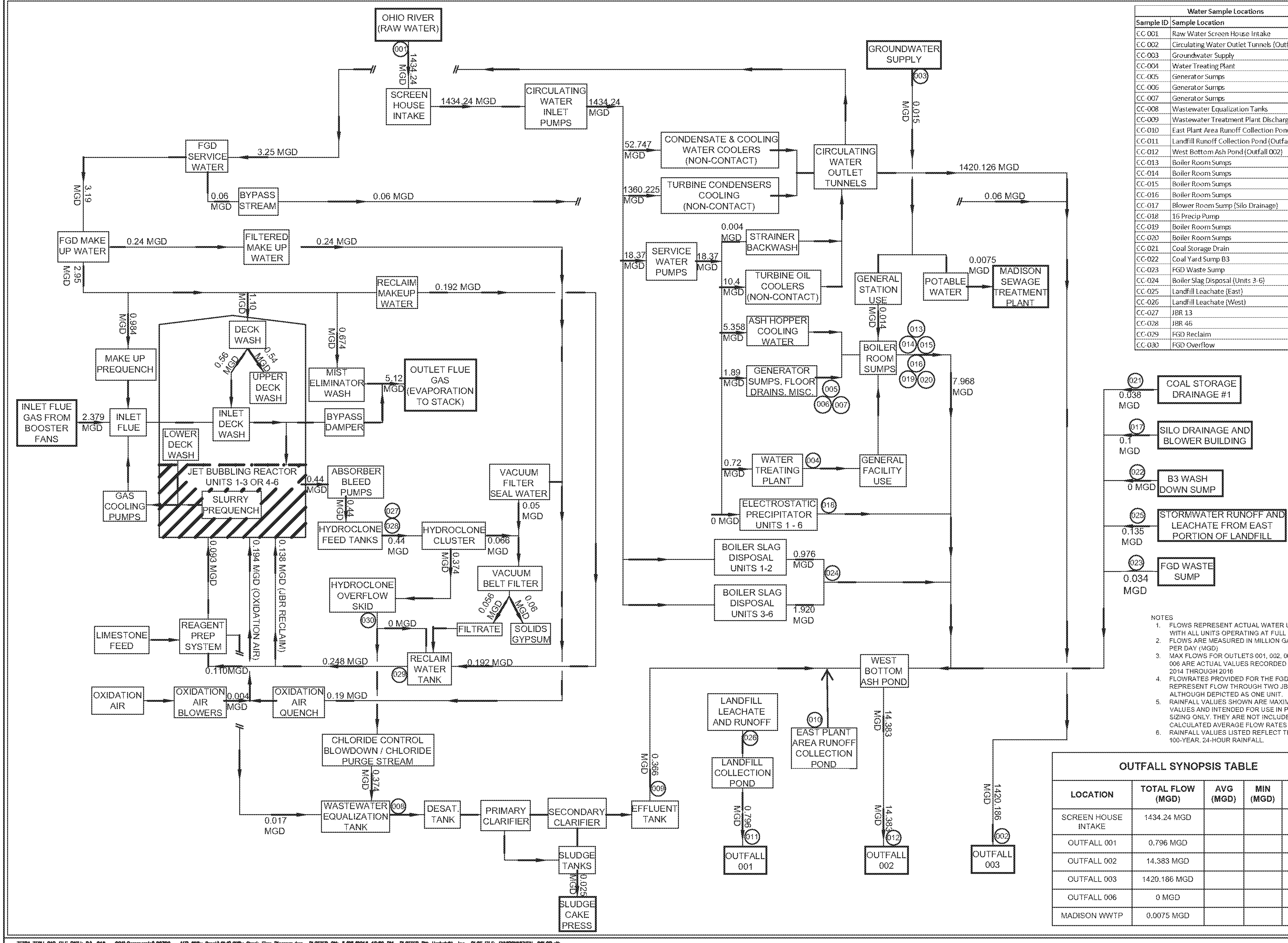
APPENDIX B – WATER BALANCE



Water Sample Locations	
Sample ID	Sample Location
CC-001	Raw Water Screen House Intake
CC-002	Circulating Water Outlet Tunnels (Outfall 003)
CC-003	Groundwater Supply
CC-004	Water Treating Plant
CC-005	Generator Sumps
CC-006	Generator Sumps
CC-007	Generator Sumps
CC-008	Wastewater Equalization Tanks
CC-009	Wastewater Treatment Plant Discharge
CC-010	East Plant Area Runoff Collection Pond
CC-011	Landfill Runoff Collection Pond (Outfall 001)
CC-012	West Bottom Ash Pond (Outfall 002)
CC-013	Boiler Room Sumps
CC-014	Boiler Room Sumps
CC-015	Boiler Room Sumps
CC-016	Boiler Room Sumps
CC-017	Blower Room Sump (Silo Drainage)
CC-018	16 Precip Pump
CC-019	Boiler Room Sumps
CC-020	Boiler Room Sumps
CC-021	Coal Storage Drain
CC-022	Coal Yard Sump B3
CC-023	FGD Waste Sump
CC-024	Boiler Slag Disposal (Units 3-6)
CC-025	Landfill Leachate (East)
CC-026	Landfill Leachate (West)
CC-027	JBR 13
CC-028	JBR 46
CC-029	FGD Reclaim
CC-030	FGD Overflow

NOTES
1. FLOWS REPRESENT ACTUAL WATER USAGE WITH ALL UNITS OPERATING AT FULL LOAD
2. FLOWS ARE MEASURED IN MILLION GALLONS PER DAY (MGD)
3. MAX FLOWS FOR OUTLETS 001, 002, 003, AND 006 ARE ACTUAL VALUES RECORDED DURING 2014 THROUGH 2016
4. FLOWRATES PROVIDED FOR THE FGD SYSTEM REPRESENT FLOW THROUGH TWO JBR UNITS, ALTHOUGH DEPICTED AS ONE UNIT.
5. RAINFALL VALUES SHOWN ARE MAXIMUM VALUES AND INTENDED FOR USE IN POND SIZING ONLY. THEY ARE NOT INCLUDED IN THE CALCULATED AVERAGE FLOW RATES SHOWN.
6. RAINFALL VALUES LISTED REFLECT THE 100-YEAR, 24-HOUR RAINFALL.

OUTFALL SYNOPSIS TABLE

LOCATION	TOTAL FLOW (MGD)	AVG (MGD)	MIN (MGD)	MAX (MGD)
SCREEN HOUSE INTAKE	1434.24 MGD			
OUTFALL 001	0.796 MGD			
OUTFALL 002	14.383 MGD			
OUTFALL 003	1420.186 MGD			
OUTFALL 006	0 MGD			
MADISON WWTP	0.0075 MGD			

REVISIONS:

NO.	DATE:	DWN.:	CHKD.:	APPD.:	DESCRIPTION:

CLIFTY CREEK GENERATING STATION
WATER BALANCE/SAMPLING DIAGRAM
MADISON COUNTY, INDIANA

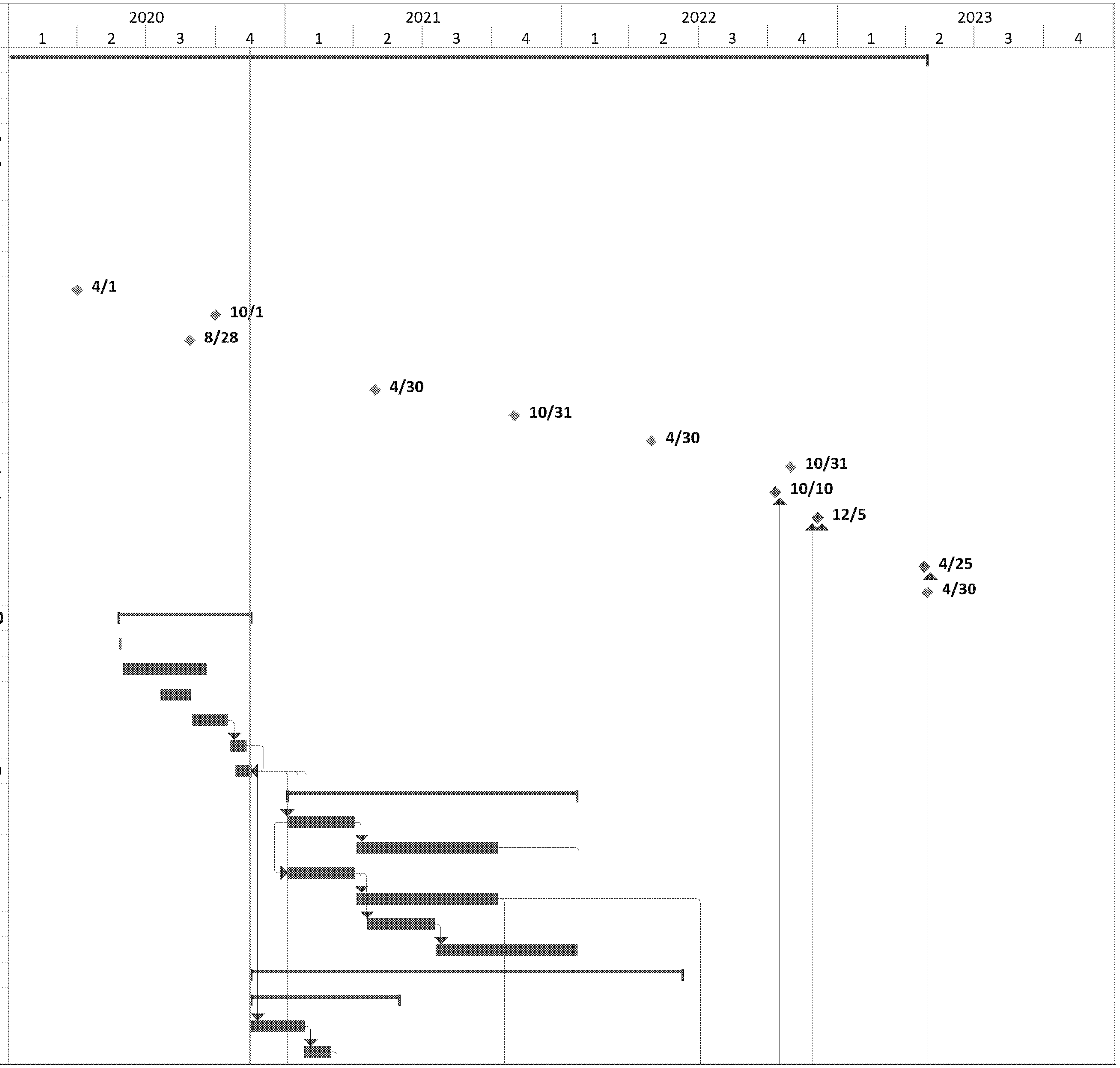
TETRA TECH
complex world | CLEAR SOLUTIONS™
661 ANDERSEN DRIVE
FOSTER PLAZA 7
PITTSBURGH, PA 15220

DRAWN BY: JH
CHECKED BY:
APPROVED BY:
DATE: 05/09/2016
SCALE: AS SHOWN
SHT. NO. OF 1
REVISION

TETRA TECH CAD FILE PATH: ... PLOTTED ON: 5/23/2016 ... PLOT FILE: ENVIRONMENTAL COLOR.ctb

APPENDIX C – SCHEDULE

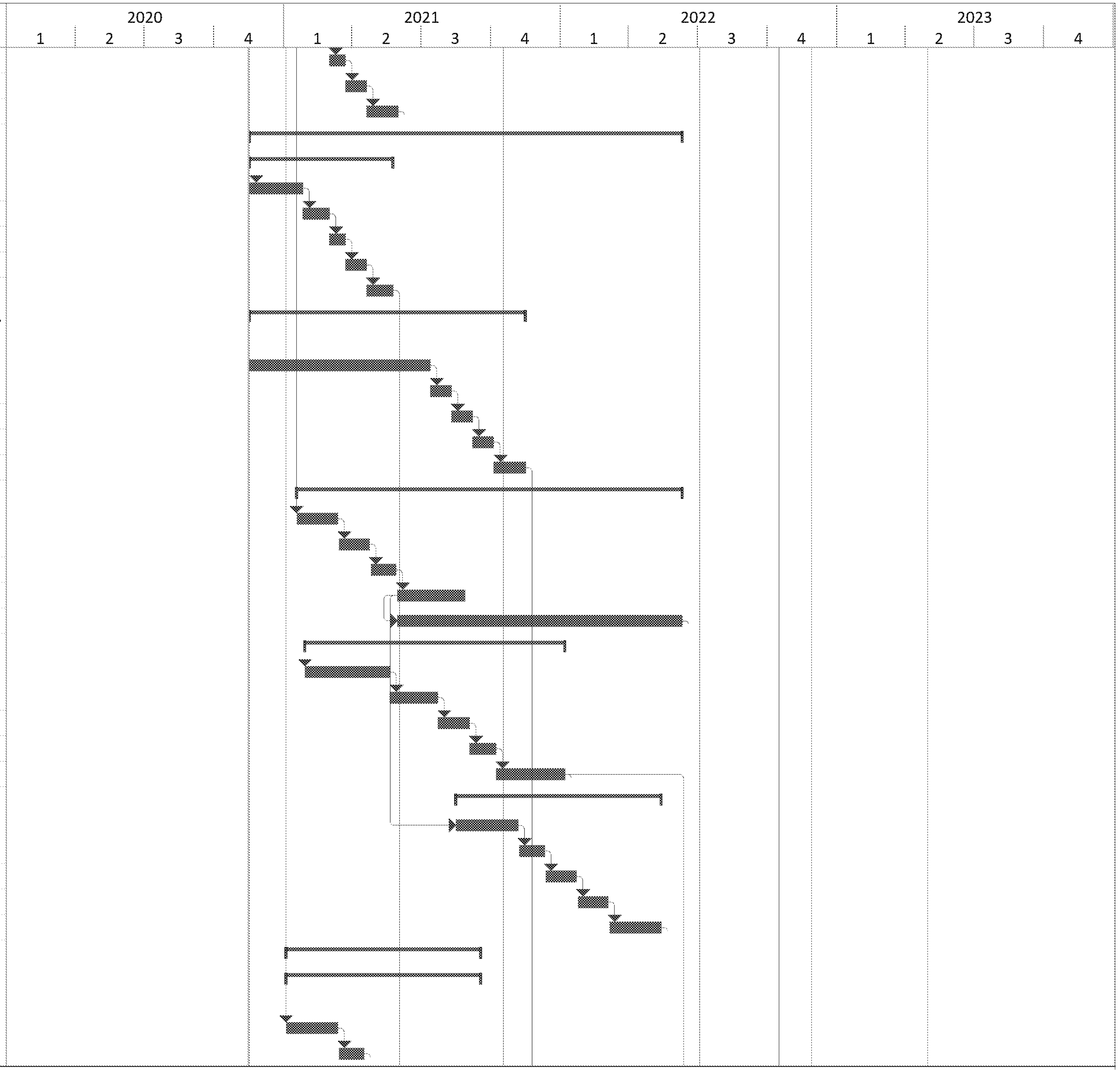
ID	Task Name	Duration	Start	Finish
1	**CCR Compliance Efforts**	**2097 days**	**Fri 4/17/15**	**Sun 4/30/23**
2	Final CCR Rule Published in Federal Register	0 days	Fri 4/17/15	Fri 4/17/15
3	Background Groundwater Sampling	413 days	Fri 1/1/16	Tue 8/1/17
4	Completed Liner Documentation	0 days	Mon 10/10/16	Mon 10/10/16
5	Prepared Surface Impoundment History of Construction	0 days	Mon 10/10/16	Mon 10/10/16
6	First Detection Monitoring Samples	0 days	Thu 3/1/18	Thu 3/1/18
7	Assessment Monitoring Program (LRCP) - First Round	0 days	Mon 10/1/18	Mon 10/1/18
8	Assessment Monitoring Program - Second Round	0 days	Mon 4/1/19	Mon 4/1/19
9	Assessment Monitoring Program - Third Round	0 days	Tue 10/1/19	Tue 10/1/19
10	Assessment Monitoring Program - Fourth Round	0 days	Wed 4/1/20	Wed 4/1/20
11	Assessment Monitoring Program - Fifth Round	0 days	Thu 10/1/20	Thu 10/1/20
12	EPA Published Final ELG Rule and CCR Holistic Approach to Closure Part A Rule	0 days	Fri 8/28/20	Fri 8/28/20
13	Semi-Annual Progress Report #1	0 days	Fri 4/30/21	Fri 4/30/21
14	Semi-Annual Progress Report #2	0 days	Sun 10/31/21	Sun 10/31/21
15	Semi-Annual Progress Report #3	0 days	Sat 4/30/22	Sat 4/30/22
16	Semi-Annual Progress Report #4	0 days	Mon 10/31/22	Mon 10/31/22
17	Cease Sluicing Boiler Slag to WBSP (BSHS in service)	0 days	Mon 10/10/22	Mon 10/10/22
18	Cease non-CCR flows to WBSP (LVWTS in service) and initiate WBSP closure	0 days	Mon 12/5/22	Mon 12/5/22
19	Cease non-CCR flows to LRCP	0 days	Tue 4/25/23	Tue 4/25/23
20	Semi-Annual Progress Report #5	0 days	Sun 4/30/23	Sun 4/30/23
21	**Budgetary and Feed Study**	**125 days**	**Tue 5/26/20**	**Mon 11/16/20**
22	Perform Laser Scan & Transmit Results	3 days	Tue 5/26/20	Thu 5/28/20
23	Complete Initial Geotechnical Investigation	80 days	Mon 6/1/20	Fri 9/18/20
24	Prepare Scope Documents and Subcontract Packages	30 days	Mon 7/20/20	Fri 8/28/20
25	Subcontractor Budget Quotes	35 days	Mon 8/31/20	Fri 10/16/20
26	Finalize Estimate and Report	15 days	Tue 10/20/20	Mon 11/9/20
27	Owner Review & Board Approval	15 days	Tue 10/27/20	Mon 11/16/20
28	**Permitting**	**275 days**	**Mon 1/4/21**	**Fri 1/21/22**
29	IDEM Permit to Install Application - BSHS	65 days	Mon 1/4/21	Fri 4/2/21
30	IDEM Permit to Install Approval - BSHS	135 days	Mon 4/5/21	Fri 10/8/21
31	IDEM Permit to Install Application - LVWTS/WBSP Closure	65 days	Mon 1/4/21	Fri 4/2/21
32	IDEM Permit to Install Approval - LVWTS/WBSP Closure	135 days	Mon 4/5/21	Fri 10/8/21
33	Prepare Application for NPDES Permit Modifications	65 days	Mon 4/19/21	Fri 7/16/21
34	IDEM Review/Approval of NPDES Permit Modification	135 days	Mon 7/19/21	Fri 1/21/22
35	**BSHS, LVWTS & Pond Closure - Procurement**	**409 days**	**Tue 11/17/20**	**Fri 6/10/22**
36	**Phase 1 - Gypsum Stackout/Pond Closure**	**140 days**	**Tue 11/17/20**	**Mon 5/31/21**
37	Develop Drawings and Specs	50 days	Tue 11/17/20	Mon 1/25/21
38	Owner Review/Issue Bid Package	25 days	Tue 1/26/21	Mon 3/1/21



Project: Clifty Creek CCR Surface Impoundments Extension Demonstration
Date: Mon 11/16/20

Task
Split
Milestone
Summary
Project Summary
External Tasks
External Milestone
Inactive Task
Inactive Milestone
Inactive Summary
Manual Task
Duration-only
Manual Summary Rollup
Manual Summary
Start-only
Finish-only
Deadline
Progress
Manual Progress

ID	Task Name	Duration	Start	Finish
39	Bid Period	15 days	Tue 3/2/21	Mon 3/22/21
40	Bid Evaluation/Award	20 days	Tue 3/23/21	Mon 4/19/21
41	Pre-Plan, Procure, and Mobilize	30 days	Tue 4/20/21	Mon 5/31/21
42	**Phase 2 - BSHS**	**409 days**	**Tue 11/17/20**	**Fri 6/10/22**
43	**BSHS Site Preparation - Procurement**	**135 days**	**Tue 11/17/20**	**Mon 5/24/21**
44	Develop Drawings and Specs	50 days	Tue 11/17/20	Mon 1/25/21
45	Owner Review/Issue Bid Package	25 days	Tue 1/26/21	Mon 3/1/21
46	Bid Period	15 days	Tue 3/2/21	Mon 3/22/21
47	Bid Evaluation/Award	20 days	Tue 3/23/21	Mon 4/19/21
48	Pre-Plan, Procure, and Mobilize	25 days	Tue 4/20/21	Mon 5/24/21
49	**BSHS Foundations & Underground Utilities Construction - Procurement**	**260 days**	**Tue 11/17/20**	**Mon 11/15/21**
50	Develop Drawings and Specs	170 days	Tue 11/17/20	Mon 7/12/21
51	Owner Review/Issue Bid Package	20 days	Tue 7/13/21	Mon 8/9/21
52	Bid Period	20 days	Tue 8/10/21	Mon 9/6/21
53	Bid Evaluation/Award	20 days	Tue 9/7/21	Mon 10/4/21
54	Pre-Plan, Procure, and Mobilize	30 days	Tue 10/5/21	Mon 11/15/21
55	**BSHS Major Electrical Equipment - Procurement**	**365 days**	**Mon 1/18/21**	**Fri 6/10/22**
56	Develop Bid Documents/Issue Bid Package	40 days	Mon 1/18/21	Fri 3/12/21
57	Bid Period	30 days	Mon 3/15/21	Fri 4/23/21
58	Review, Negotiate and Award	25 days	Mon 4/26/21	Fri 5/28/21
59	Review and Approve Submittals	65 days	Mon 5/31/21	Fri 8/27/21
60	Fabricate/Deliver to Site	270 days	Mon 5/31/21	Fri 6/10/22
61	**BSHS/LVWTS Mechanical Construction - Procurement**	**245 days**	**Fri 1/29/21**	**Thu 1/6/22**
62	Develop Drawings and Specs	80 days	Fri 1/29/21	Thu 5/20/21
63	Owner Review/Issue Bid Package	45 days	Fri 5/21/21	Thu 7/22/21
64	Bid Period	30 days	Fri 7/23/21	Thu 9/2/21
65	Bid Evaluation/Award	25 days	Fri 9/3/21	Thu 10/7/21
66	Pre-Plan, Procure, and Mobilize	65 days	Fri 10/8/21	Thu 1/6/22
67	**BSHS/LVWTS Electrical Construction - Procurement**	**195 days**	**Mon 8/16/21**	**Fri 5/13/22**
68	Develop Drawings and Specs	60 days	Mon 8/16/21	Fri 11/5/21
69	Owner Review/Issue Bid Package	25 days	Mon 11/8/21	Fri 12/10/21
70	Bid Period	30 days	Mon 12/13/21	Fri 1/21/22
71	Bid Evaluation/Award	30 days	Mon 1/24/22	Fri 3/4/22
72	Pre-Plan, Procure, and Mobilize	50 days	Mon 3/7/22	Fri 5/13/22
73	**Phase 2 & 3 - Pond Closure/LVWTS**	**185 days**	**Mon 1/4/21**	**Fri 9/17/21**
74	**LVWTS Modifications & Site Finishing Construction - Procurement**	**185 days**	**Mon 1/4/21**	**Fri 9/17/21**
75	Develop Drawings and Specs	50 days	Mon 1/4/21	Fri 3/12/21
76	Owner Review/Issue Bid Package	25 days	Mon 3/15/21	Fri 4/16/21



Project: Clifty Creek CCR Surface Impoundments Extension Demonstration
Date: Mon 11/16/20

Task	External Tasks	Manual Task	Finish-only
Split	External Milestone	Duration-only	Deadline
Milestone	Inactive Task	Manual Summary Rollup	Progress
Summary	Inactive Milestone	Manual Summary	Manual Progress
Project Summary	Inactive Summary	Start-only	

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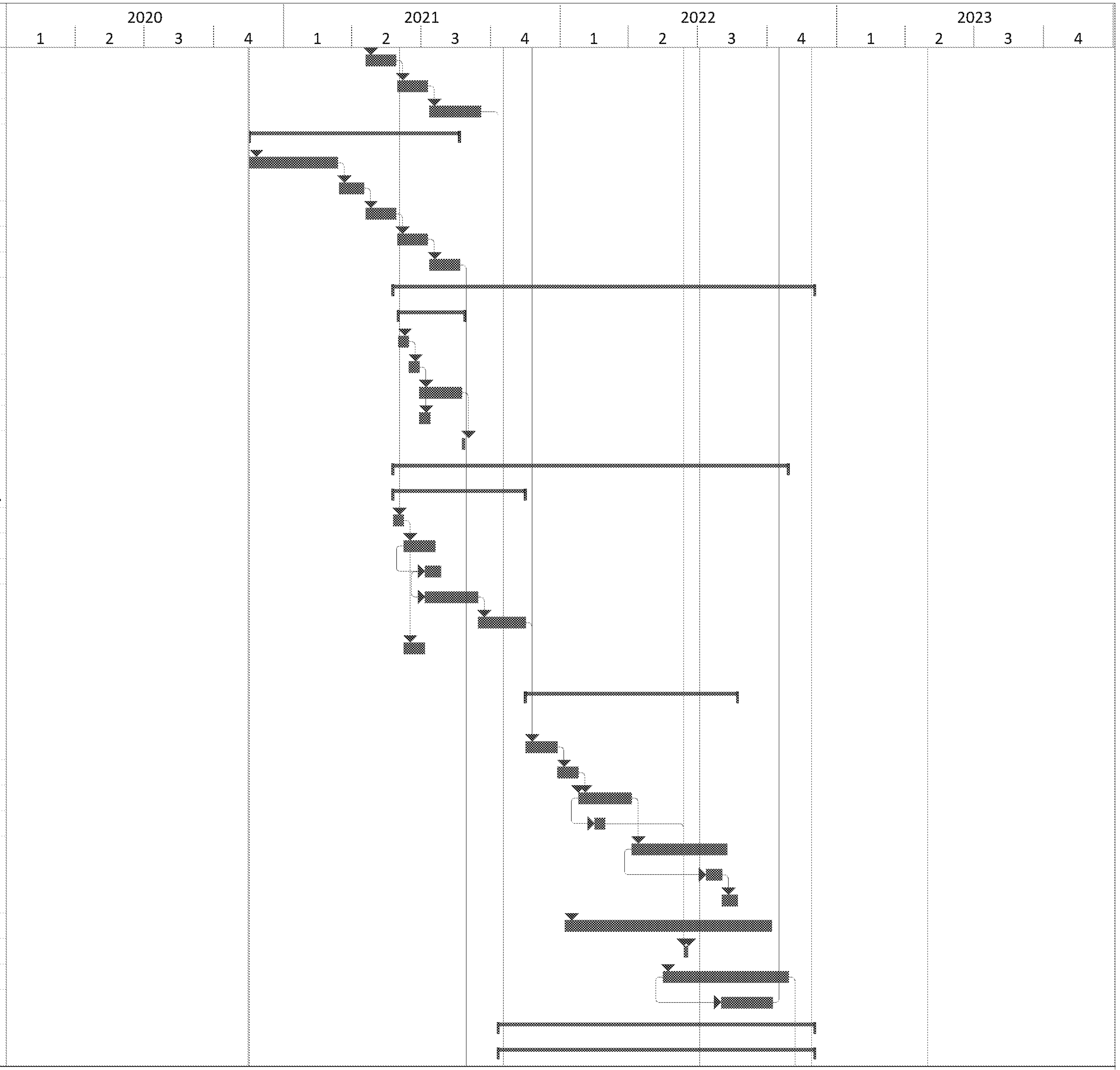
ID	Task Name	Duration	Start	Finish
77	Bid Period	30 days	Mon 4/19/21	Fri 5/28/21
78	Bid Evaluation/Award	30 days	Mon 5/31/21	Fri 7/9/21
79	Pre-Plan, Procure, and Mobilize	50 days	Mon 7/12/21	Fri 9/17/21
80	**LRCP Water Redirects/Pond Closure - Procurement**	**199 days**	**Tue 11/17/20**	**Fri 8/20/21**
81	Develop Drawings and Specs	84 days	Tue 11/17/20	Fri 3/12/21
82	Owner Review/Issue Bid Package	25 days	Mon 3/15/21	Fri 4/16/21
83	Bid Period	30 days	Mon 4/19/21	Fri 5/28/21
84	Bid Evaluation/Award	30 days	Mon 5/31/21	Fri 7/9/21
85	Pre-Plan, Procure, and Mobilize	30 days	Mon 7/12/21	Fri 8/20/21
86	**BSHS, LVWTS & Pond Closure - Construction**	**399 days**	**Tue 5/25/21**	**Fri 12/2/22**
87	**Phase 1 - Gypsum Stackout/Pond Closure**	**64 days**	**Tue 6/1/21**	**Fri 8/27/21**
88	Install Erosion Controls/Clear & Grub	10 days	Tue 6/1/21	Mon 6/14/21
89	Ash Grading	10 days	Tue 6/15/21	Mon 6/28/21
90	Install Cover System	40 days	Tue 6/29/21	Mon 8/23/21
91	Access Road Paving	10 days	Tue 6/29/21	Mon 7/12/21
92	Seed & Mulch	4 days	Tue 8/24/21	Fri 8/27/21
93	**Phase 2 - BSHS**	**374 days**	**Tue 5/25/21**	**Fri 10/28/22**
94	**BSHS Site Preparation - Construction**	**125 days**	**Tue 5/25/21**	**Mon 11/15/21**
95	Install Erosion Controls/Clear & Grub	10 days	Tue 5/25/21	Mon 6/7/21
96	Divert Incoming Flows Around Work Area	30 days	Tue 6/8/21	Mon 7/19/21
97	Dewater Work Area	15 days	Tue 7/6/21	Mon 7/26/21
98	Stockpile Material for Surcharge	50 days	Tue 7/6/21	Mon 9/13/21
99	Surcharge Loading	45 days	Tue 9/14/21	Mon 11/15/21
100	Rough Grade Area for PCM, Chem Feed & Major Utility Corridor	20 days	Tue 6/8/21	Mon 7/5/21
101	**BSHS/LVWTS Foundations & Underground Utilities - Construction**	**200 days**	**Tue 11/16/21**	**Mon 8/22/22**
102	Excavate Surcharge Material	30 days	Tue 11/16/21	Mon 12/27/21
103	Prep Settling Tank Subgrade	20 days	Tue 12/28/21	Mon 1/24/22
104	Build Settling Tank Foundation Slab	50 days	Tue 1/25/22	Mon 4/4/22
105	Chem Feed, PCM, and Transformer Foundations	10 days	Tue 2/15/22	Mon 2/28/22
106	Build Settling Tank Walls	90 days	Tue 4/5/22	Mon 8/8/22
107	Backfill Settling Tank (after outer walls are complete)	15 days	Tue 7/12/22	Mon 8/1/22
108	Stackout Slab Foundation	15 days	Tue 8/2/22	Mon 8/22/22
109	BSHS/LVWTS Mechanical	195 days	Fri 1/7/22	Thu 10/6/22
110	Set PCM	5 days	Mon 6/13/22	Fri 6/17/22
111	BSHS/LVWTS Electrical	120 days	Mon 5/16/22	Fri 10/28/22
112	BSHS Startup & Commissioning	50 days	Mon 8/1/22	Fri 10/7/22
113	**Phase 2 & 3 - Pond Closure/LVWTS**	**300 days**	**Mon 10/11/21**	**Fri 12/2/22**
114	**LVWTS Modifications & Site Finishing - Construction**	**300 days**	**Mon 10/11/21**	**Fri 12/2/22**



Project: Clifty Creek CCR Surface Impoundments Extension Demonstration
Date: Mon 11/16/20

Task		External Tasks		Manual Task		Finish-only	
Split		External Milestone		Duration-only		Deadline	
Milestone		Inactive Task		Manual Summary Rollup		Progress	
Summary		Inactive Milestone		Manual Summary		Manual Progress	
Project Summary		Inactive Summary		Start-only			

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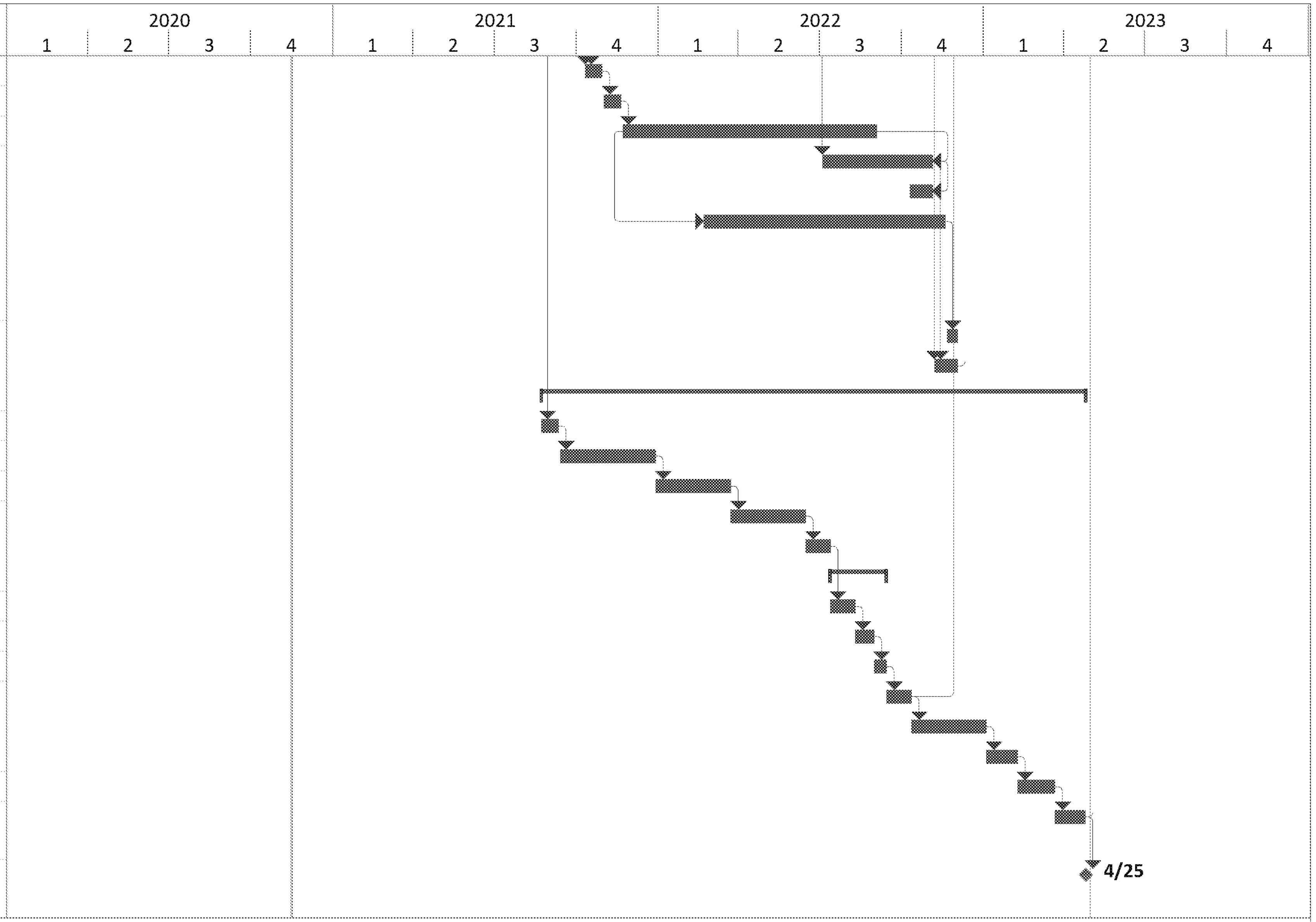
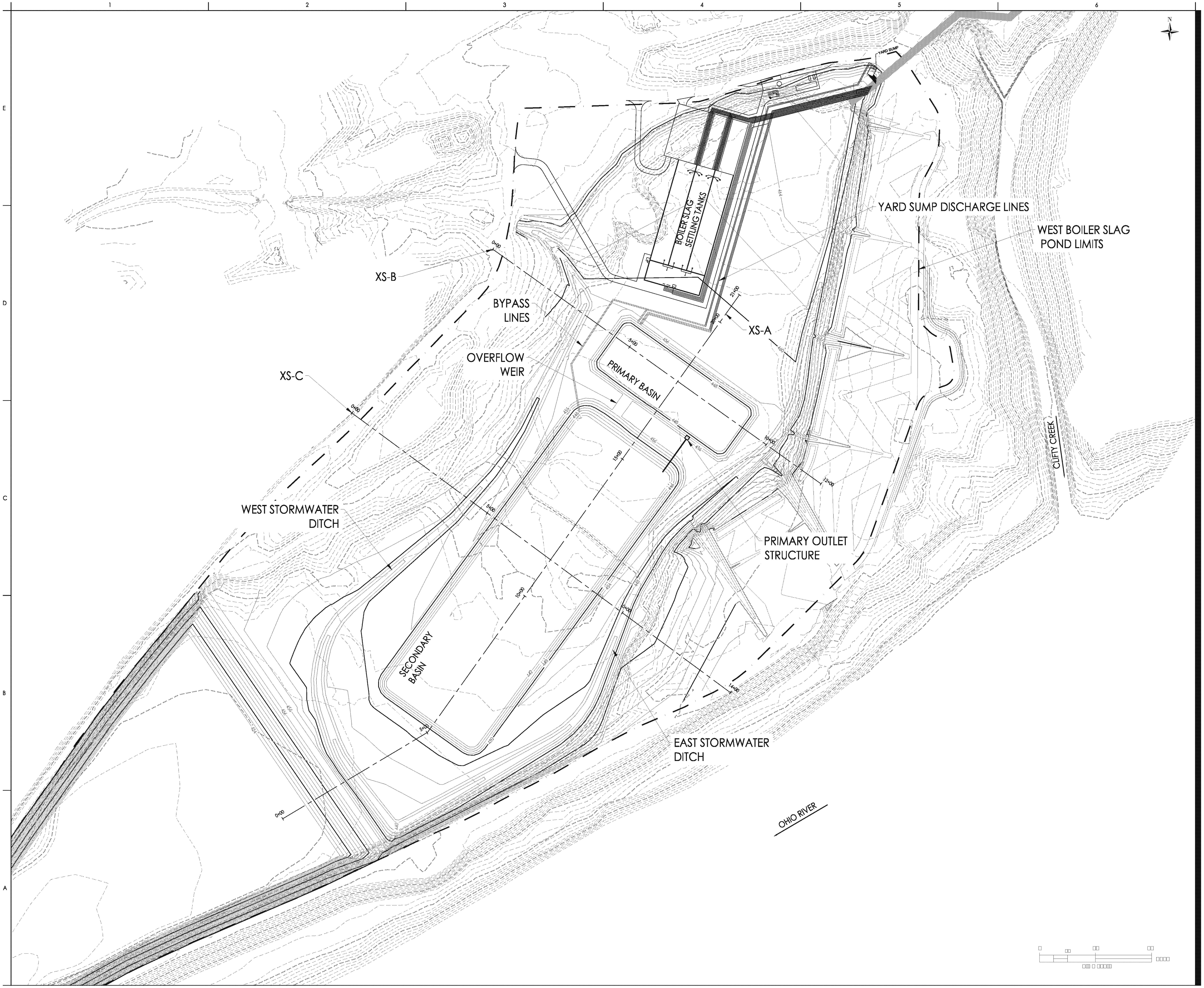
ID	Task Name	Duration	Start	Finish
115	Clear & Grub	15 days	Mon 10/11/21	Fri 10/29/21
116	Stormwater Diversion Channels	15 days	Mon 11/1/21	Fri 11/19/21
117	Ash Grading (includes LVWTS footprint)	205 days	Mon 11/22/21	Fri 9/2/22
118	Install LVWTS Composite Liner System	90 days	Mon 7/4/22	Fri 11/4/22
119	Install New Stormwater Outfall	20 days	Mon 10/10/22	Fri 11/4/22
120	Install Cover System (for portions required to convey flow from LVWTS to new outfall structure - Phase 4 closure completion is not material to the demonstration)	195 days	Mon 2/21/22	Fri 11/18/22
121	Seed & Mulch	10 days	Mon 11/21/22	Fri 12/2/22
122	LVWTS Startup & Commissioning	20 days	Mon 11/7/22	Fri 12/2/22
123	**LRCP Construction Activitities**	**438 days**	**Mon 8/23/21**	**Tue 4/25/23**
124	Install Erosion Controls/Clear & Grub	15 days	Mon 8/23/21	Fri 9/10/21
125	Dredge Portion of LRCP	77 days	Mon 9/13/21	Tue 12/28/21
126	Install Offsite Stormwater Diversion Ditch	60 days	Wed 12/29/21	Tue 3/22/22
127	Construct West Landfill Collection Pond	60 days	Wed 3/23/22	Tue 6/14/22
128	Install New Leachate Collection System	20 days	Wed 6/15/22	Tue 7/12/22
129	**Install Landfill Temporary Cover**	**45 days**	**Wed 7/13/22**	**Tue 9/13/22**
130	Ash Grading	20 days	Wed 7/13/22	Tue 8/9/22
131	Temporary Soil Cover	15 days	Wed 8/10/22	Tue 8/30/22
132	Seed & Mulch	10 days	Wed 8/31/22	Tue 9/13/22
133	Install East Leachate Collection Pond	20 days	Wed 9/14/22	Tue 10/11/22
134	Construct Landfill Sediment Pond	60 days	Wed 10/12/22	Tue 1/3/23
135	Construct West Leachate Collection Pond	25 days	Wed 1/4/23	Tue 2/7/23
136	Construct Landfill Treatment Pond	30 days	Wed 2/8/23	Tue 3/21/23
137	Install Cover System (for portions required to convey flow from new landfill ponds to existing outfall structure)	25 days	Wed 3/22/23	Mon 4/24/23
138	Flows diverted from LRCP (final closure activities happening after this date are not material to the demonstration)	0 days	Tue 4/25/23	Tue 4/25/23



Project: Clifty Creek CCR Surface Impoundments Extension Demonstration
Date: Mon 11/16/20

Task	External Tasks	Manual Task	Finish-only
Split	External Milestone	Duration-only	Deadline
Milestone	Inactive Task	Manual Summary Rollup	Progress
Summary	Inactive Milestone	Manual Summary	Manual Progress
Project Summary	Inactive Summary	Start-only	

APPENDIX D – STANTEC PRELIMINARY DESIGN FIGURES



Stantec
11687 Lebanon Road
Cincinnati, Ohio 45241-2012
Tel: (513) 842-8200
www.stantec.com

Consultant

Notes

1. FINAL GRADE SURFACE ELEVATIONS ARE CONCEPTUAL ONLY AND ARE SUBJECT TO CHANGE DURING DETAILED DESIGN.
2. AN ALTERNATIVE CONFIGURATION WITH THE SECONDARY BASIN LOCATED IN THE FOOTPRINT OF THE SOUTHWEST CORNER OF THE WEST BOILER SLAG POND AND LOCATED OFF OF THE FINAL CAP HAS NOT BEEN SHOWN. THIS ALTERNATIVE WILL BE EVALUATED DURING DETAILED DESIGN
3. PRIMARY AND SECONDARY BASIN GEOMETRY ANDS AND ELEVATIONS SHOWN ARE PRELIMINARY AND CONCEPTUAL IN NATURE AND SUBJECT TO CHANGE
4. EXISTING GROUND SURFACE TAKEN FROM HREZO ENGINEERING SURVEY. DWG DATED 10/9/2020 PROVIDED BY B&McD.
5. CLAY LAYER / HISTORIC CCR UNIT BOTTOM SURFACE ESTIMATED FROM HISTORIC CINDER STORAGE AREA DESIGN DRAWINGS, DATED 10/25/1954

		By	Appd	YYYY.MM.DD
0	ISSUED FOR INFORMATION	NM	JH	2020.11.10

Issued

Dwn. Dsgn. Chkd. YYYY.MM.DD

Permit/Seal

Client/Project Logo

OVEC IKEC

Client/Project

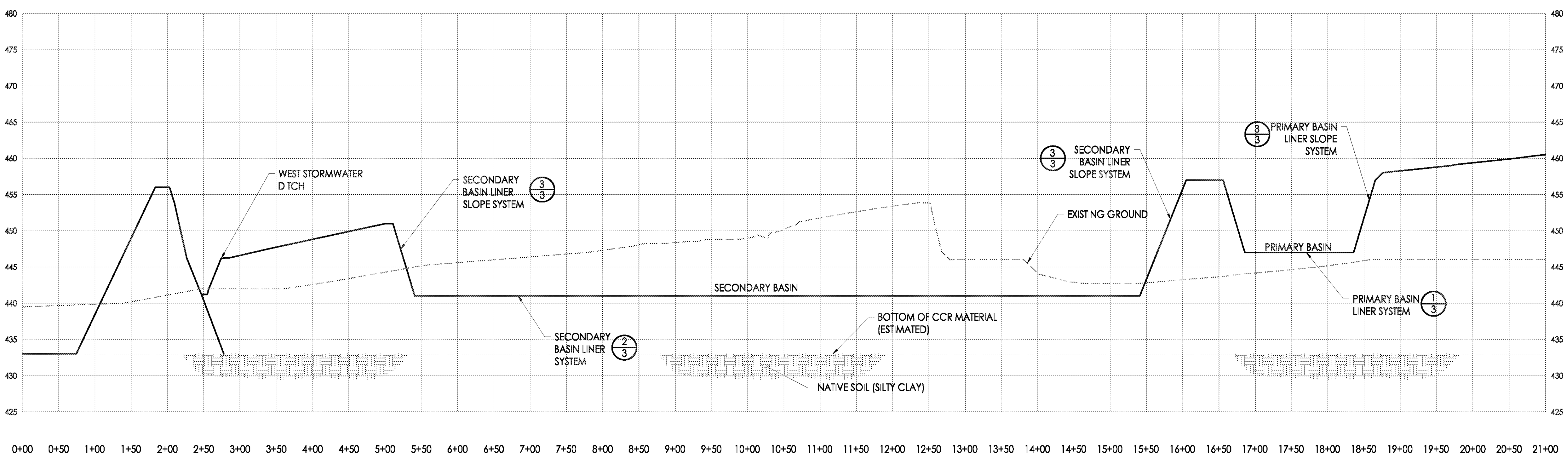
Title

LOW VOLUME WASTE TREATMENT SYSTEM
CONCEPTUAL LAYOUT

Project No. Scale

Revision Sheet Drawing No.
1 of 3

ED_006570_00010329-00063



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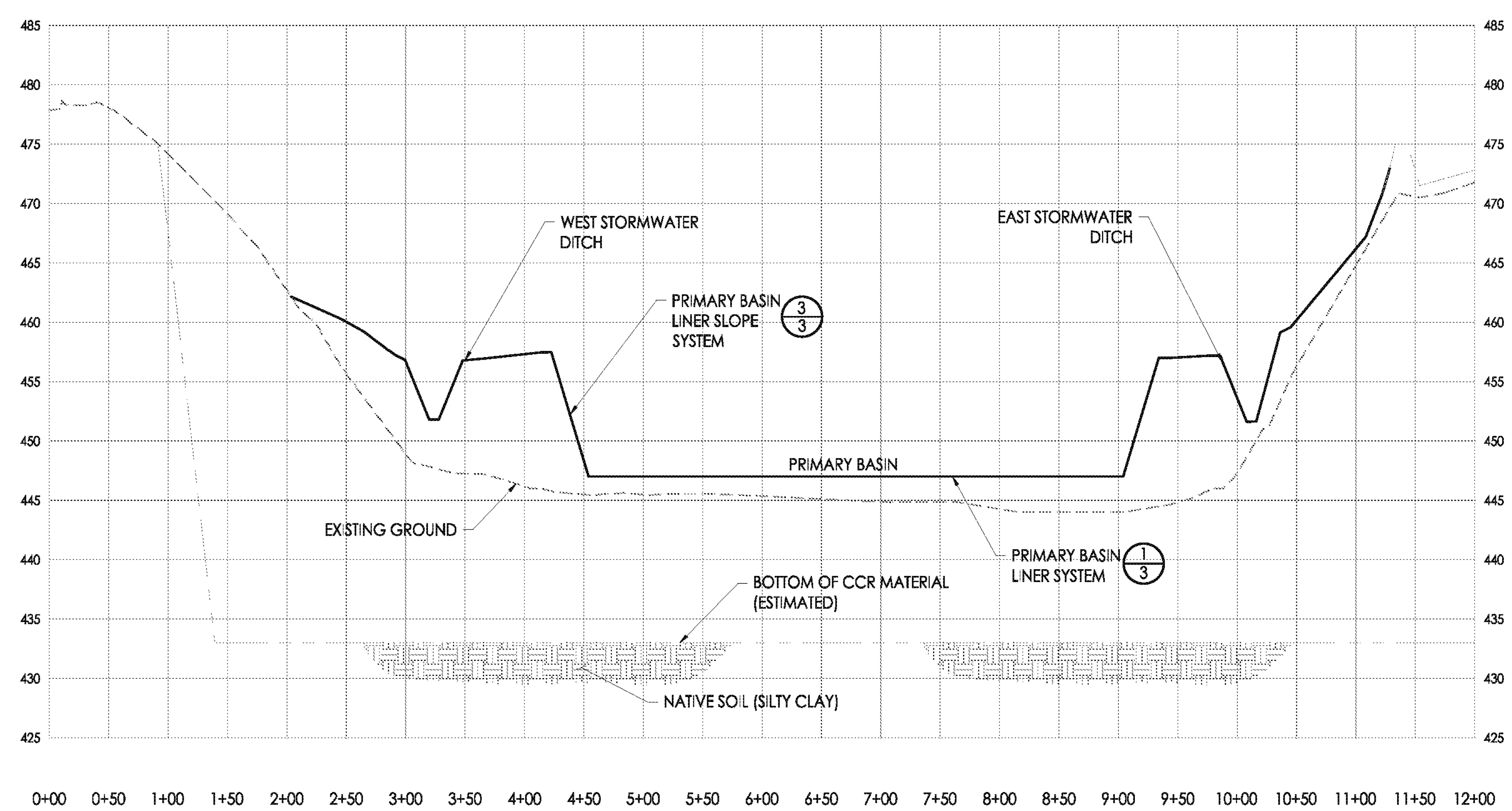

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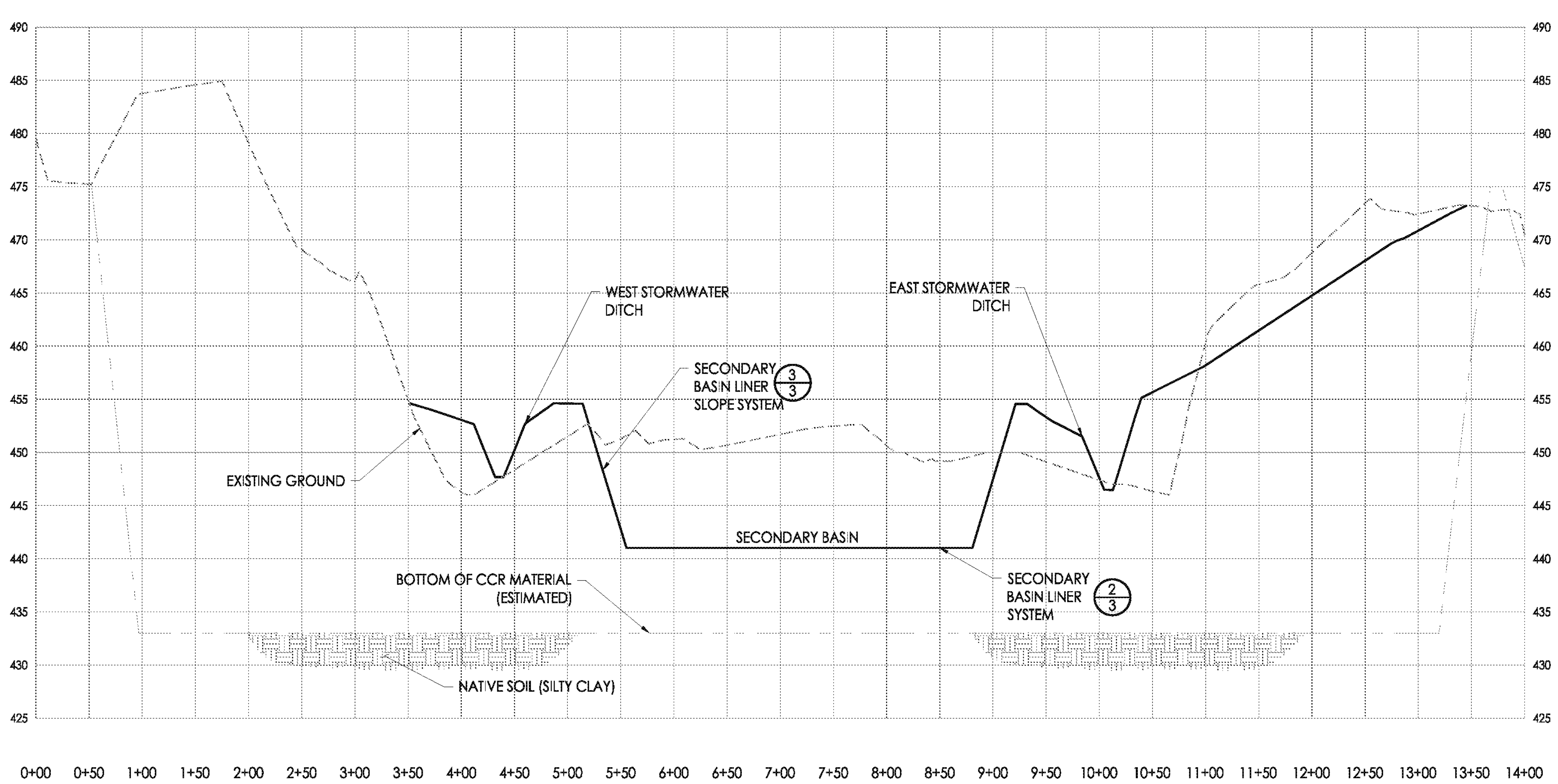

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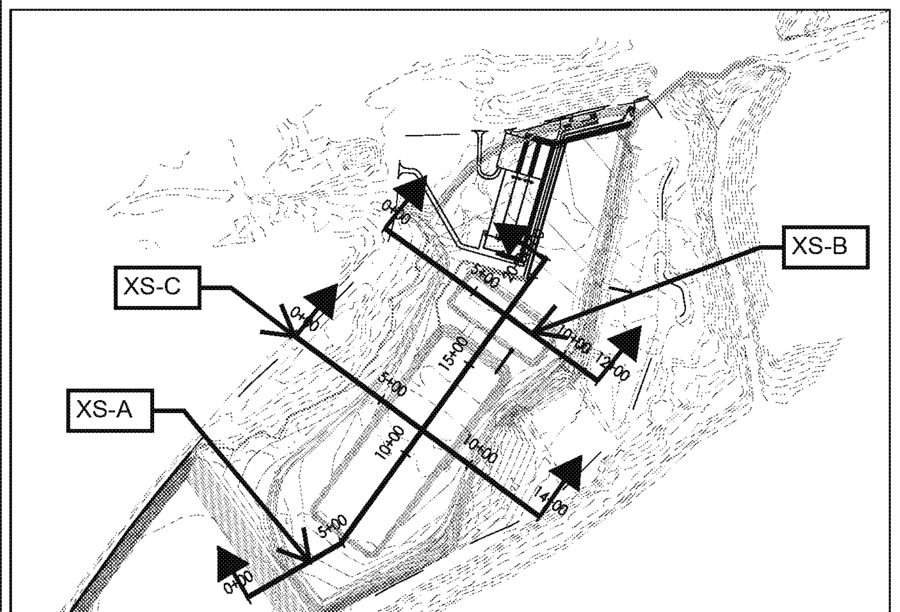

KEY PLAN
SCALE: 1" = 500'

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Dwn.	Dsgn.	Chkd.	YYYY.

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Title

LOW VOLUME WASTE TREATMENT SYSTEM
CONCEPTUAL CROSS SECTIONS

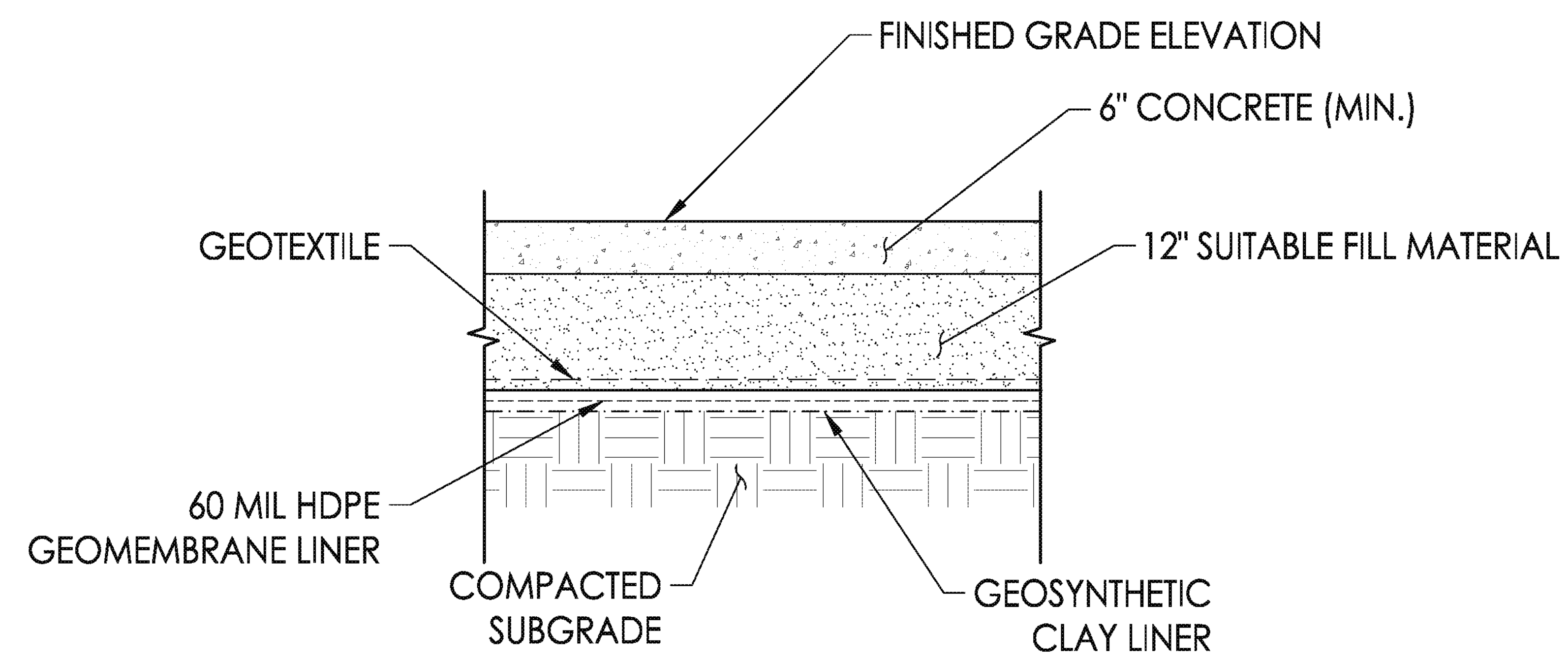
Project No.

Scale

Revision

Sheet
2 of 3

Drawing No.



1/3 LVWTS_PRIMARY_BASIN_TYPICAL_BOTTOM_SURFACE
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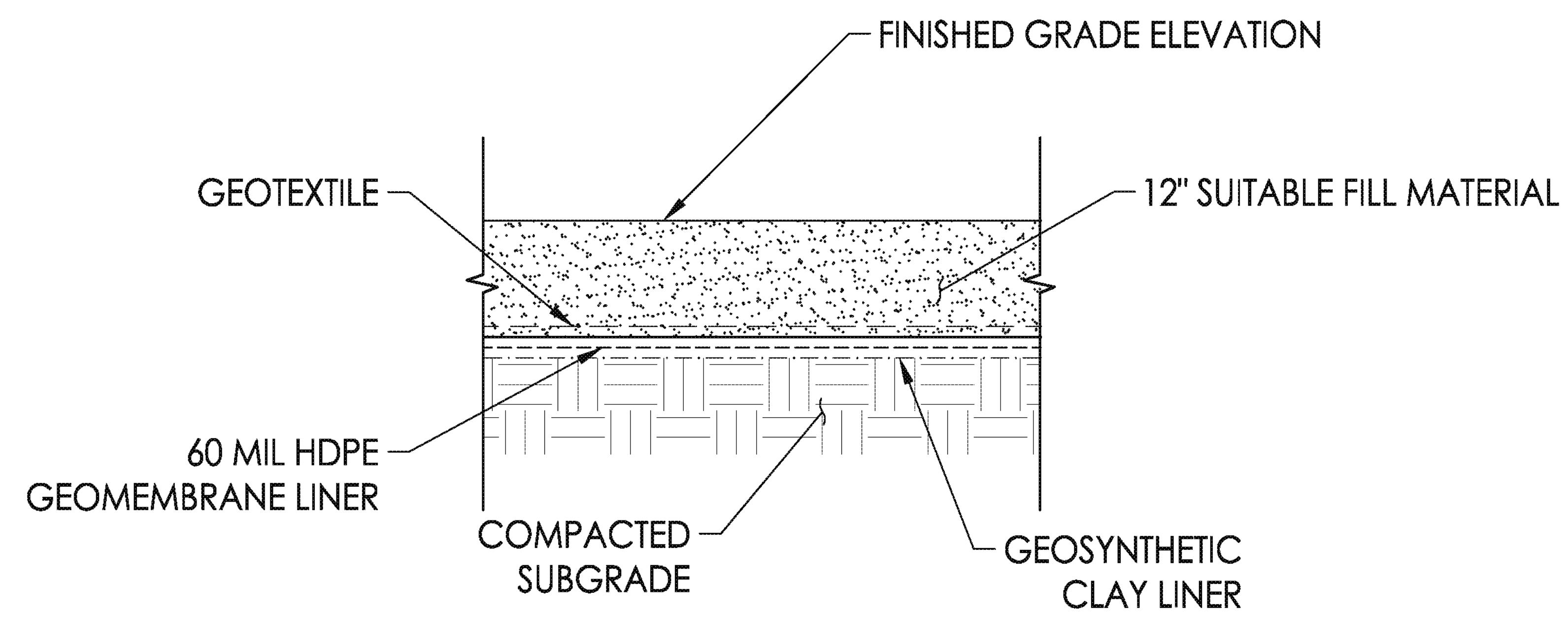
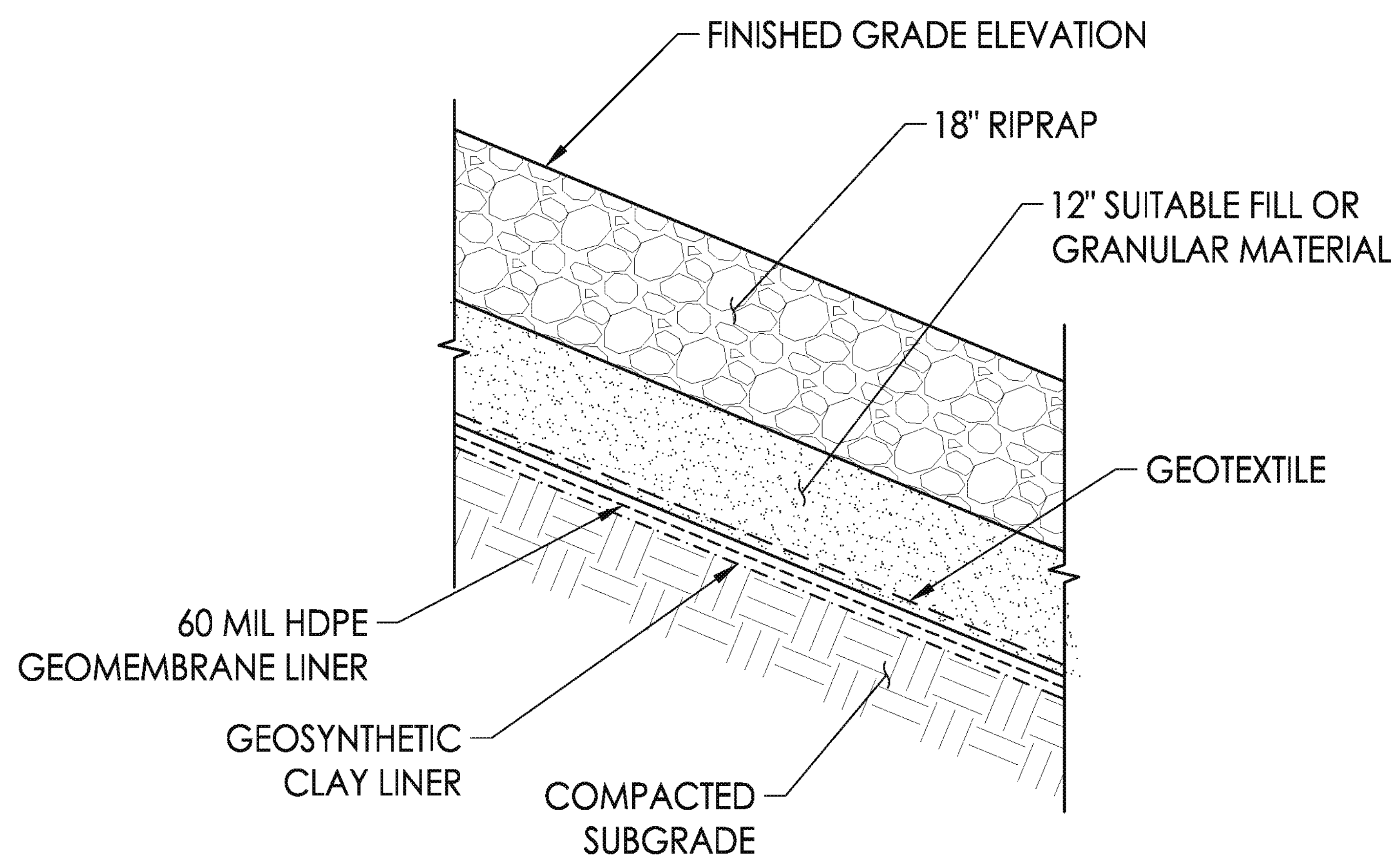


2/3 LVWTS_SECONDARY_BASIN_TYPICAL_BOTTOM_SURFACE
NOT_TO_SCALE



3/3 LVWTS_PRIMARY_AND_SECONDARY_BASIN_TYPICAL_SLOPE_SURFACE
NOT_TO_SCALE

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Issued	By	Appd	YYYY.MM.DD
0 ISSUED FOR INFORMATION	NM	JH	2020.11.10

	Dwn.	Dsgn.	Chkd.	YYYY.MM.DD

Permit/Seal

Client/Project Logo

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Client/Project

Title

LOW VOLUME WASTE TREATMENT SYSTEM
LINER DETAILS

Project No.

Scale

Revision

Sheet 3 of 3

Drawing No.

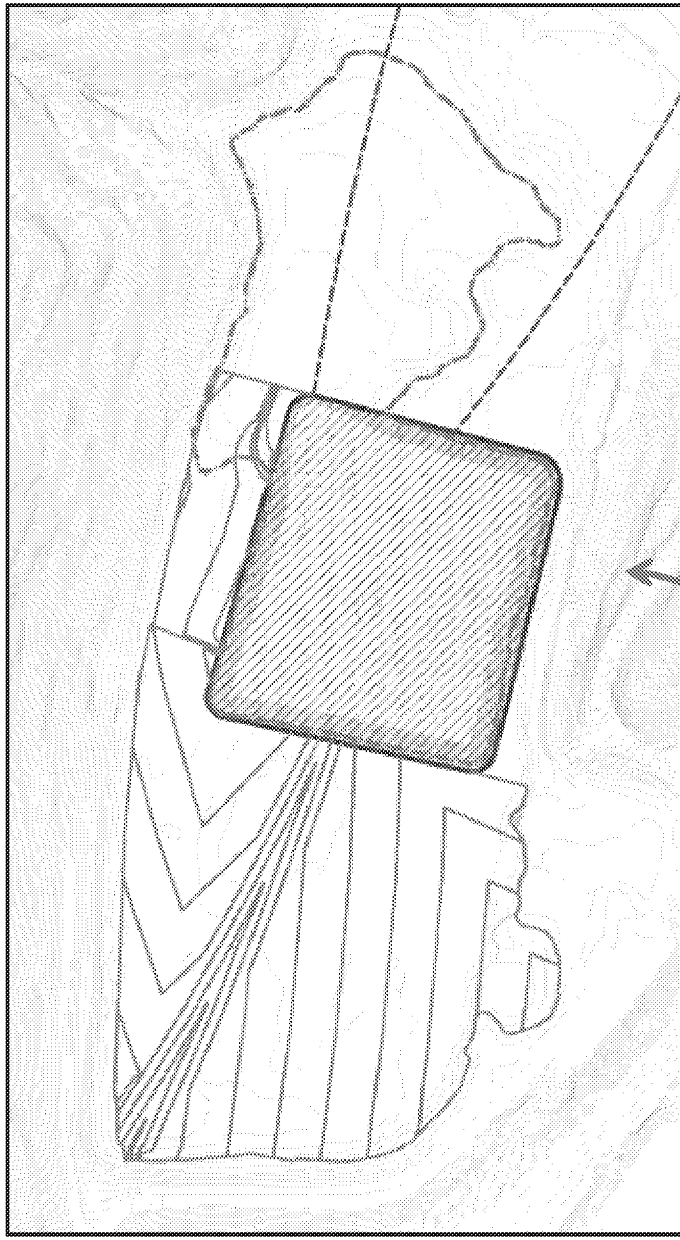
Clifty Creek Station
Landfill Runoff Collection Pond
Closure - Conceptual Plan

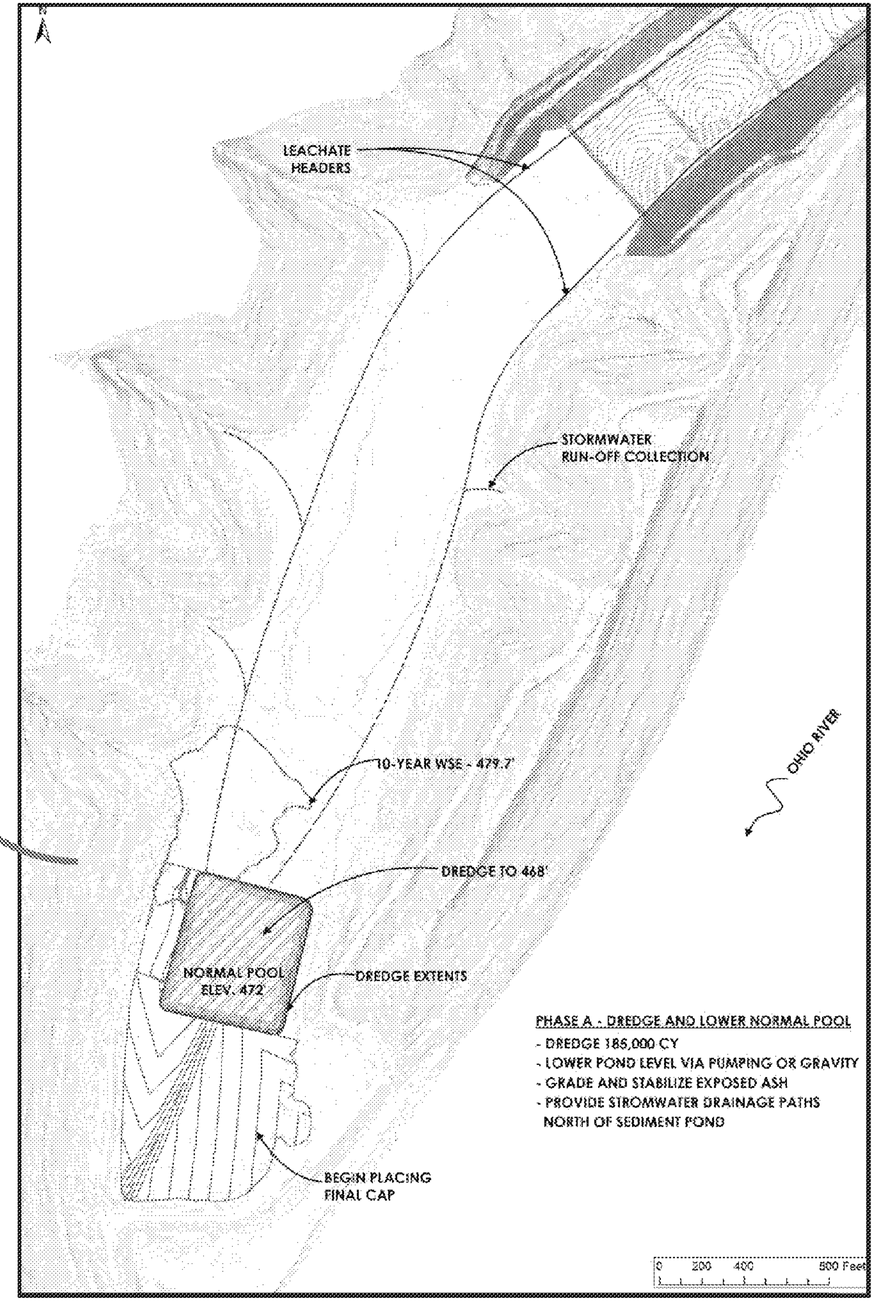
March 12, 2020 (rev 1)

Stantec

Existing Conditions

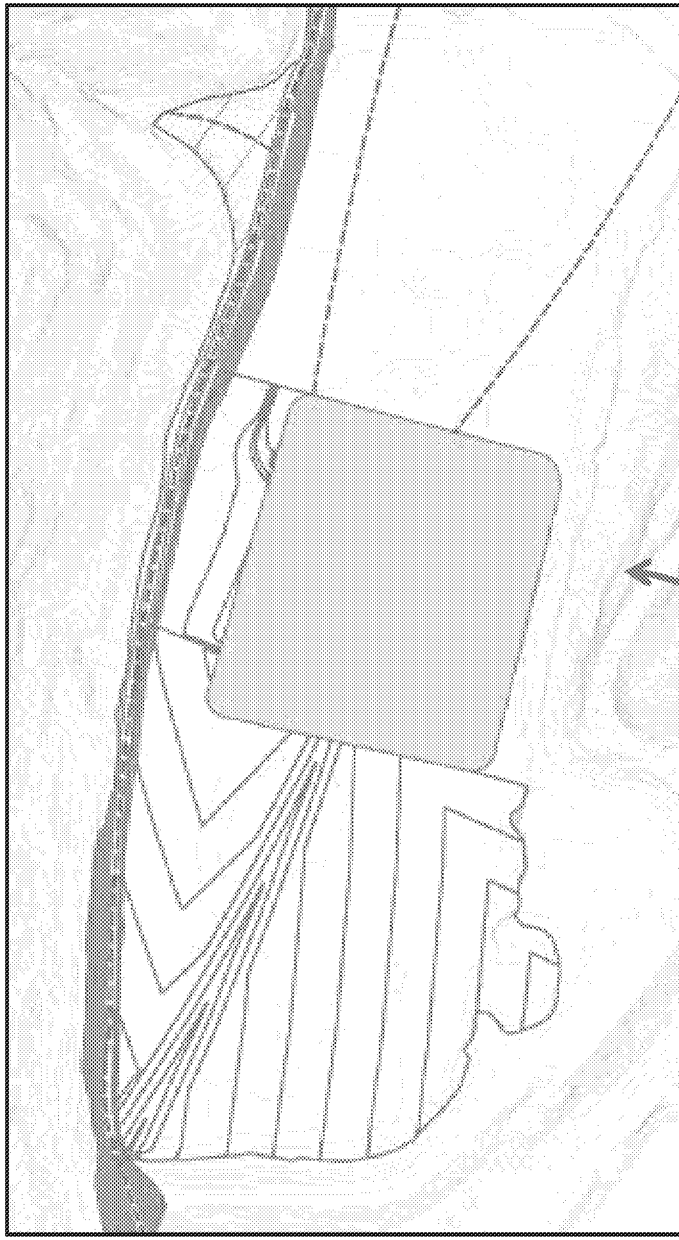
Phase A

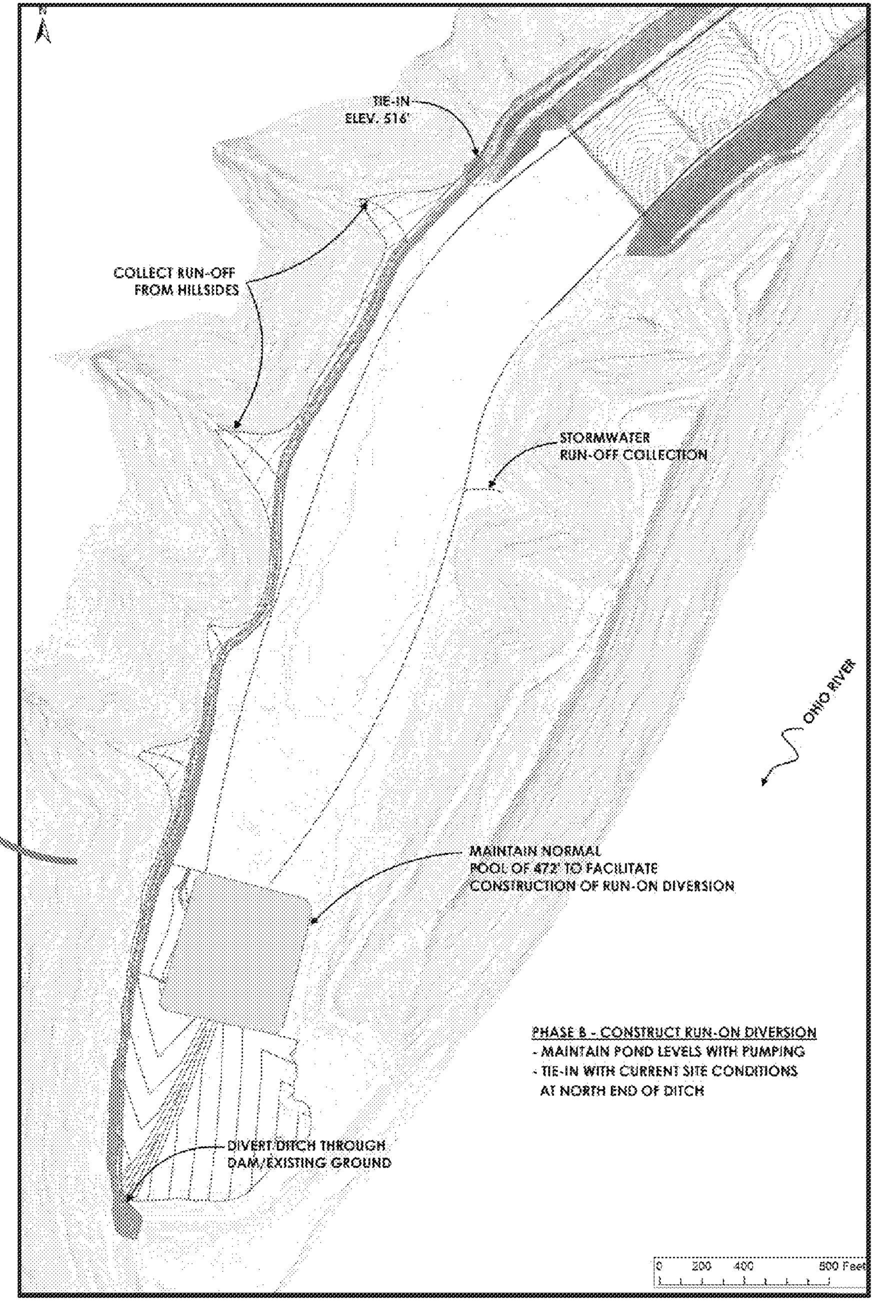




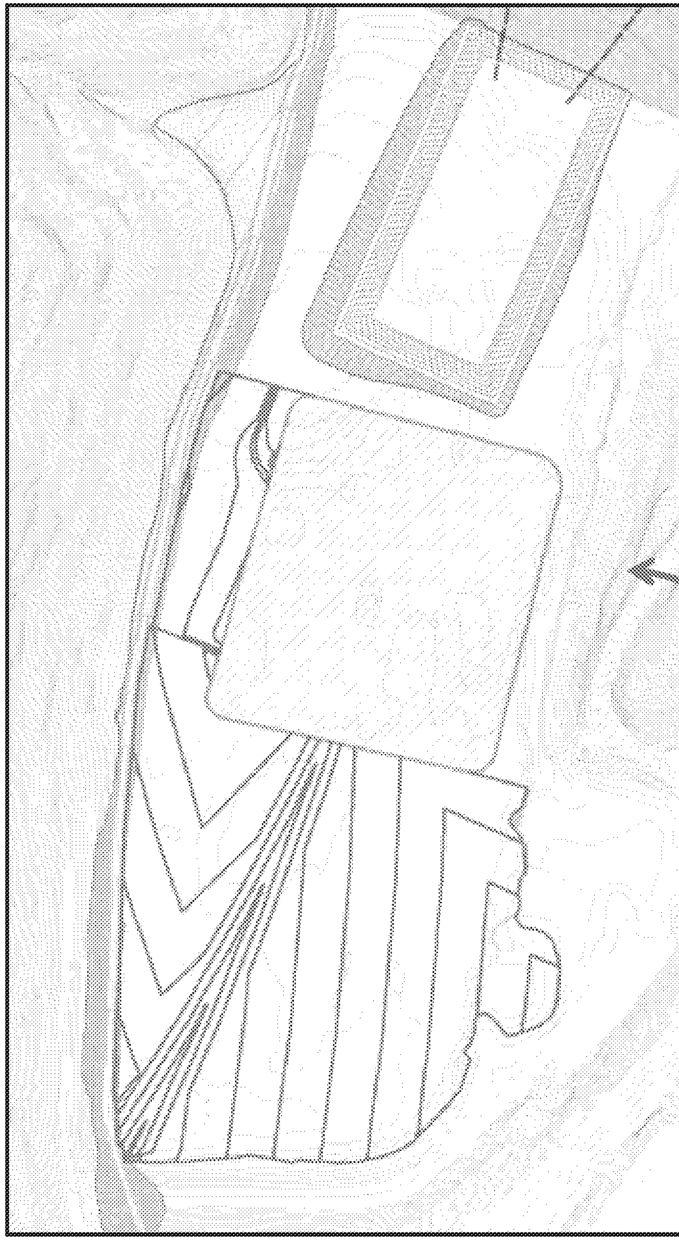
LEACHATE HEADERS
STORMWATER RUN-OFF COLLECTION
OHIO RIVER
10-YEAR WSE - 479.7'
DREDGE TO 468'
NORMAL POOL ELEV. 472
DREDGE EXTENTS
PHASE A - DREDGE AND LOWER NORMAL POOL
- DREDGE 185,000 CY
- LOWER POND LEVEL VIA PUMPING OR GRAVITY
- GRADE AND STABILIZE EXPOSED ASH
- PROVIDE STROMWATER DRAINAGE PATHS NORTH OF SEDIMENT POND
BEGIN PLACING FINAL CAP
0 200 400 800 Feet

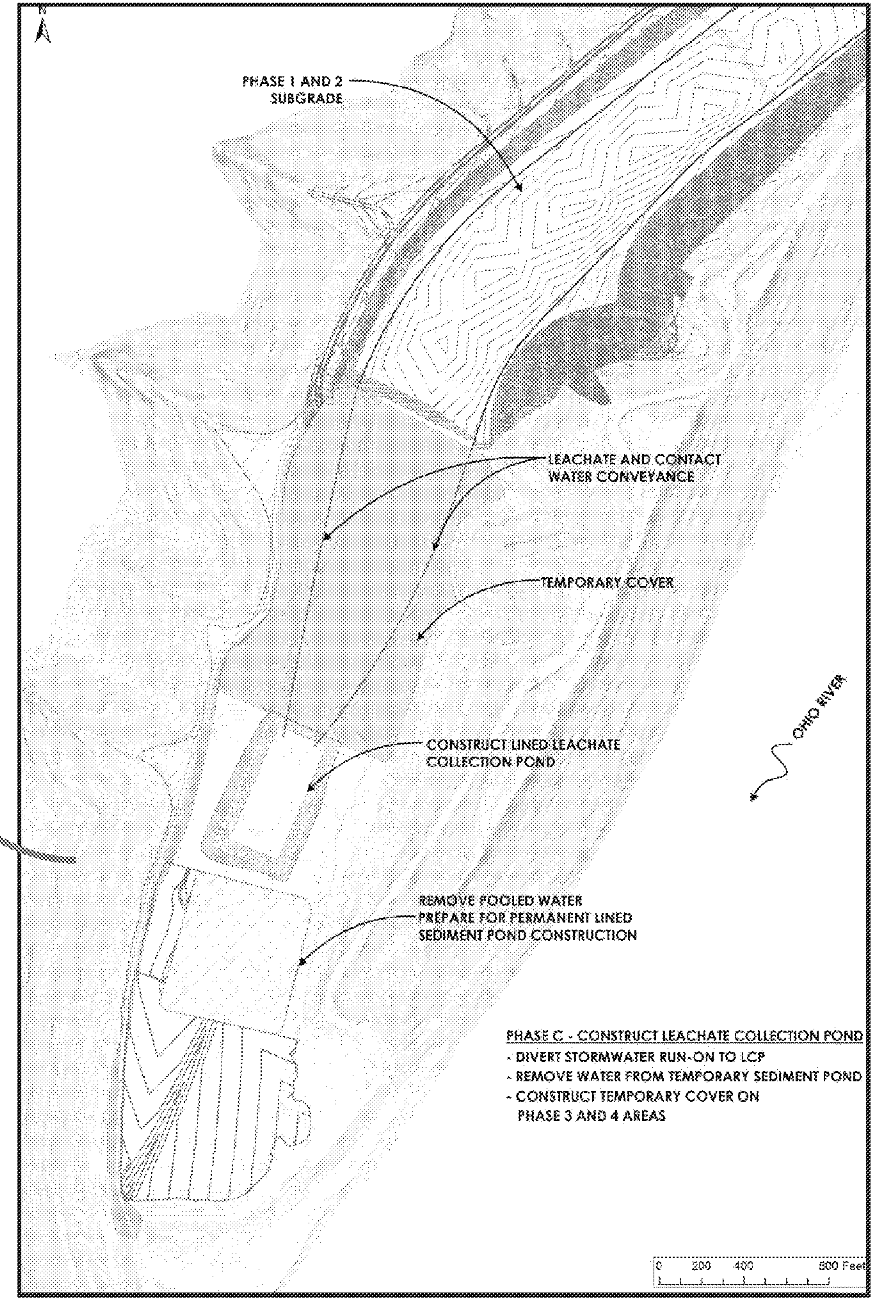
Phase B



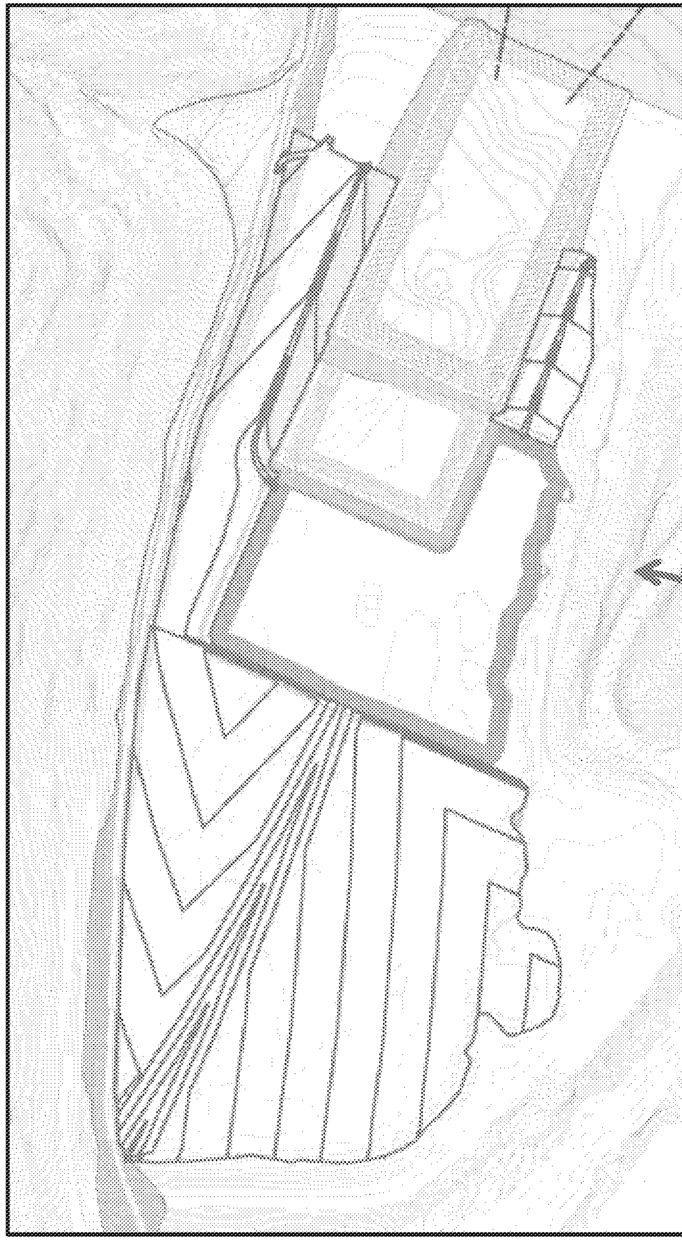

N
TIE-IN
ELEV. 516'
COLLECT RUN-OFF
FROM HILLSIDES
STORMWATER
RUN-OFF COLLECTION
OHIO RIVER
MAINTAIN NORMAL
POOL OF 472' TO FACILITATE
CONSTRUCTION OF RUN-ON DIVERSION
PHASE B - CONSTRUCT RUN-ON DIVERSION
- MAINTAIN POND LEVELS WITH PUMPING
- TIE-IN WITH CURRENT SITE CONDITIONS
AT NORTH END OF DITCH
DIVERT DITCH THROUGH
DAM/EXISTING GROUND
0 200 400 500 Feet

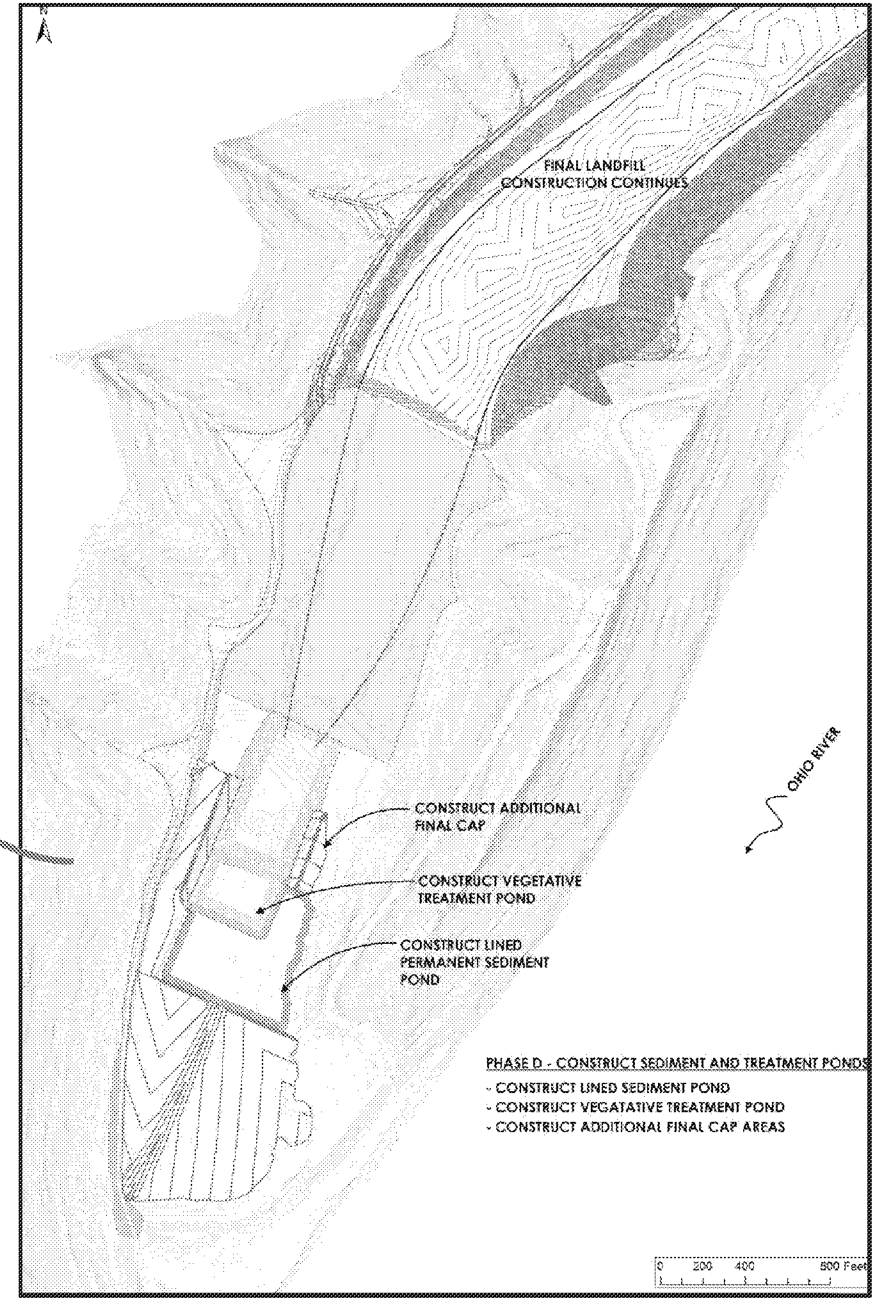
Phase C




PHASE 1 AND 2
SUBGRADE
LEACHATE AND CONTACT
WATER CONVEYANCE
TEMPORARY COVER
OHIO RIVER
CONSTRUCT LINED LEACHATE
COLLECTION POND
REMOVE POOLED WATER
PREPARE FOR PERMANENT LINED
SEDIMENT POND CONSTRUCTION
PHASE C - CONSTRUCT LEACHATE COLLECTION POND
- DIVERT STORMWATER RUN-ON TO LCP
- REMOVE WATER FROM TEMPORARY SEDIMENT POND
- CONSTRUCT TEMPORARY COVER ON
PHASE 3 AND 4 AREAS
0 200 400 800 Feet

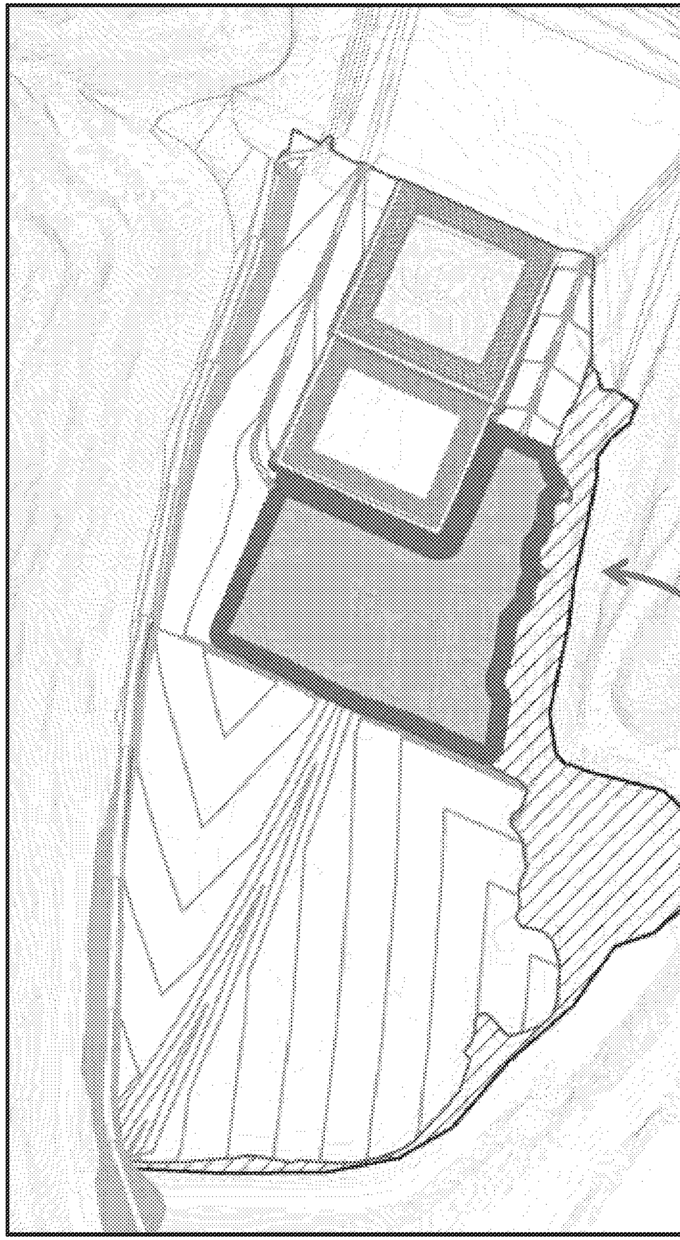
Phase D

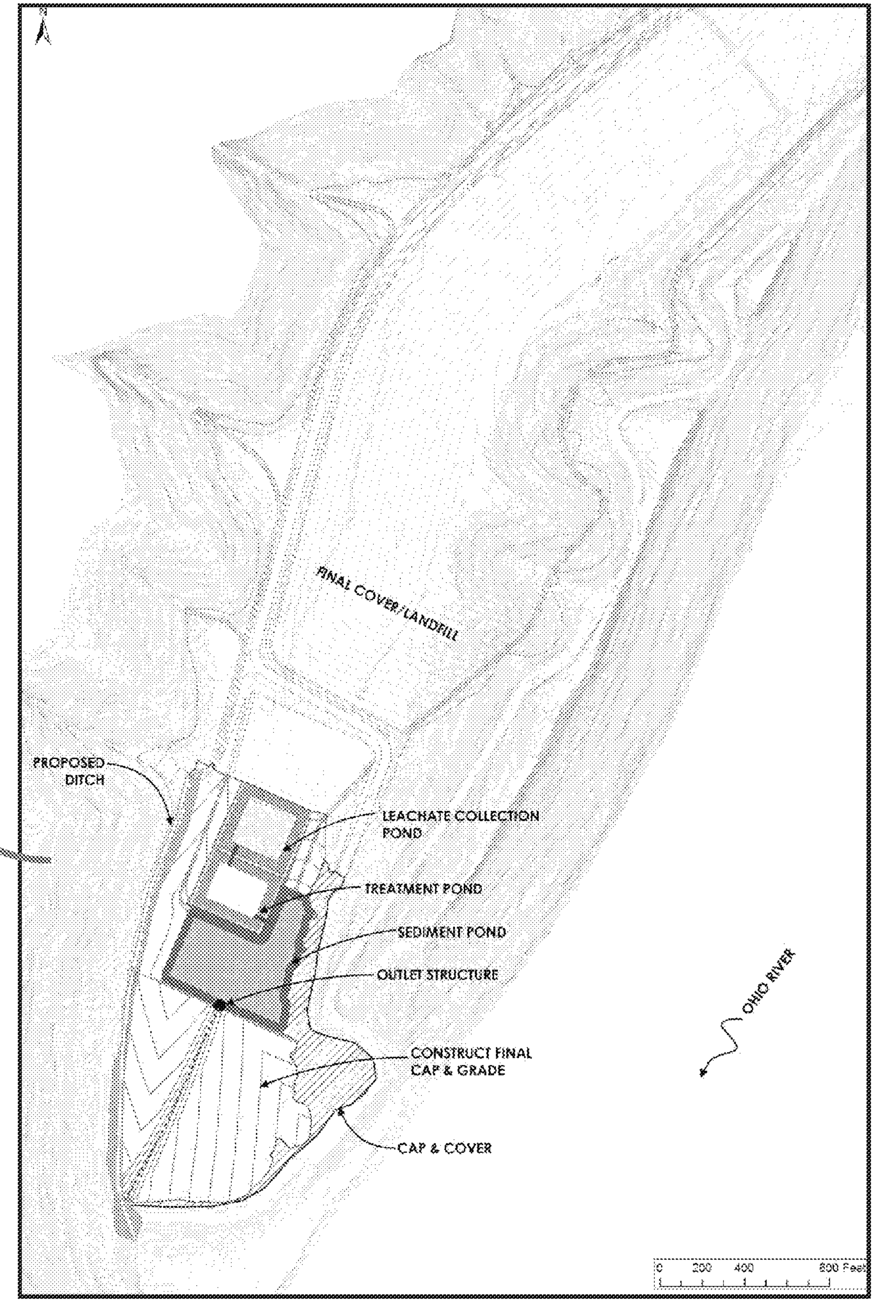




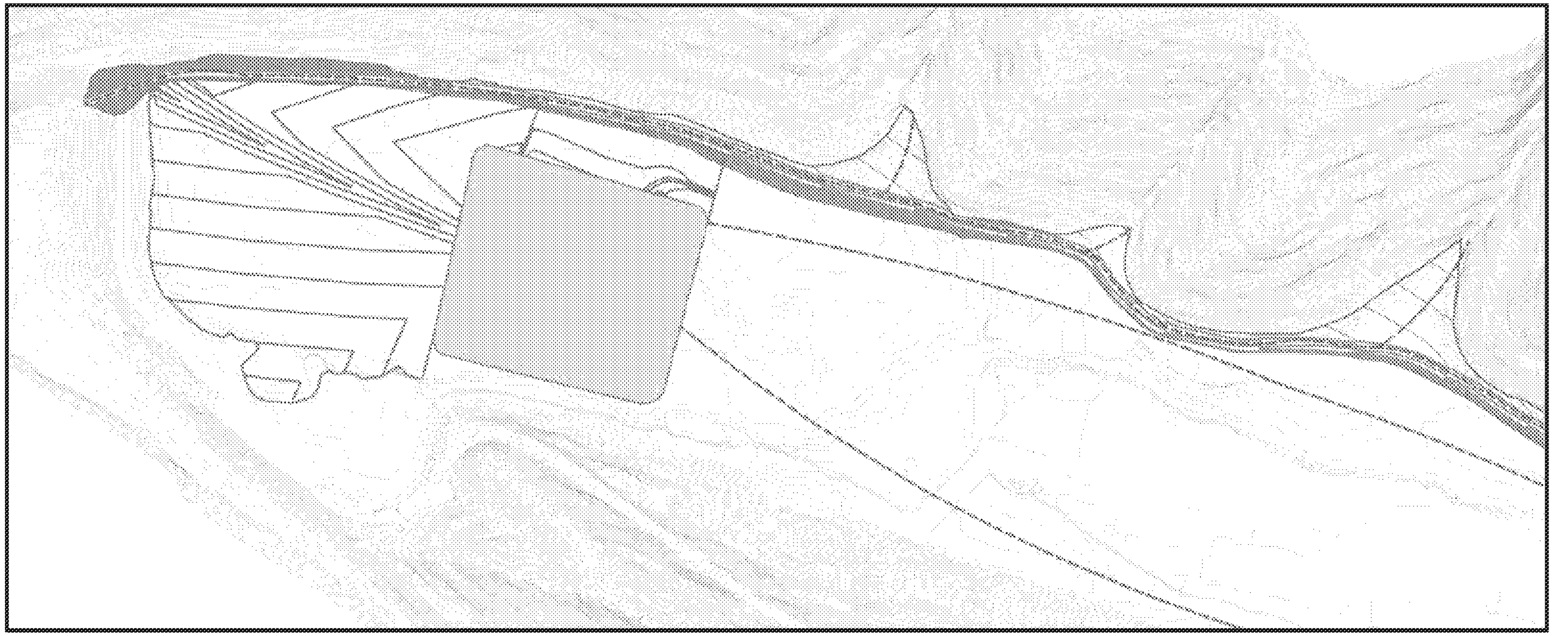
FINAL LANDFILL
CONSTRUCTION CONTINUES
OHIO RIVER
CONSTRUCT ADDITIONAL FINAL CAP
CONSTRUCT VEGETATIVE TREATMENT POND
CONSTRUCT LINED PERMANENT SEDIMENT POND
PHASE D - CONSTRUCT SEDIMENT AND TREATMENT PONDS
- CONSTRUCT LINED SEDIMENT POND
- CONSTRUCT VEGATATIVE TREATMENT POND
- CONSTRUCT ADDITIONAL FINAL CAP AREAS
0 200 400 800 Feet

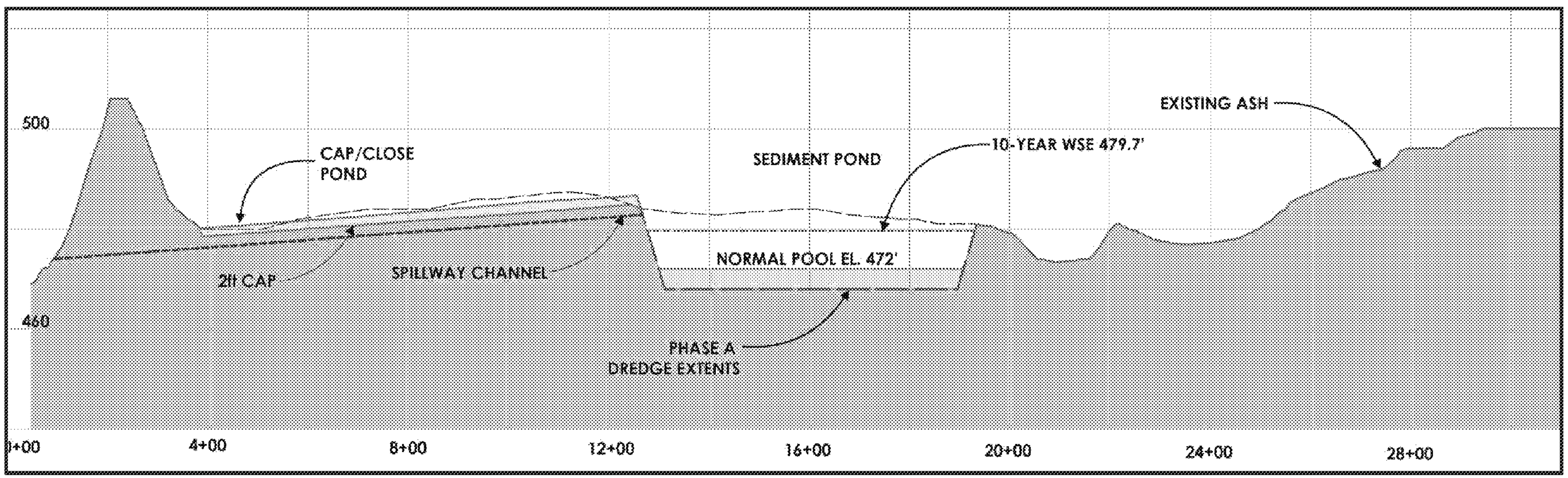
Final



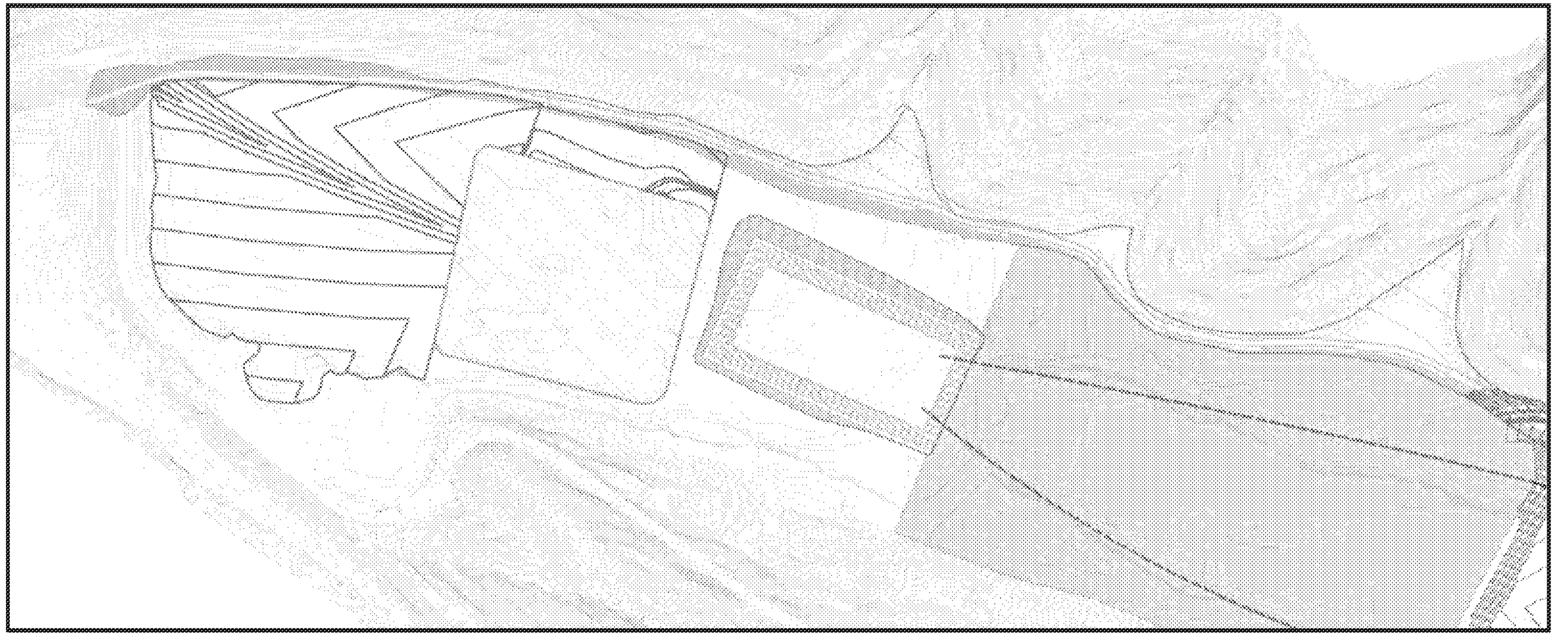

FINAL COVER/LANDFILL
PROPOSED DITCH
LEACHATE COLLECTION POND
TREATMENT POND
SEDIMENT POND
OUTLET STRUCTURE
CONSTRUCT FINAL CAP & GRADE
CAP & COVER
OHIO RIVER
0 200 400 800 Feet

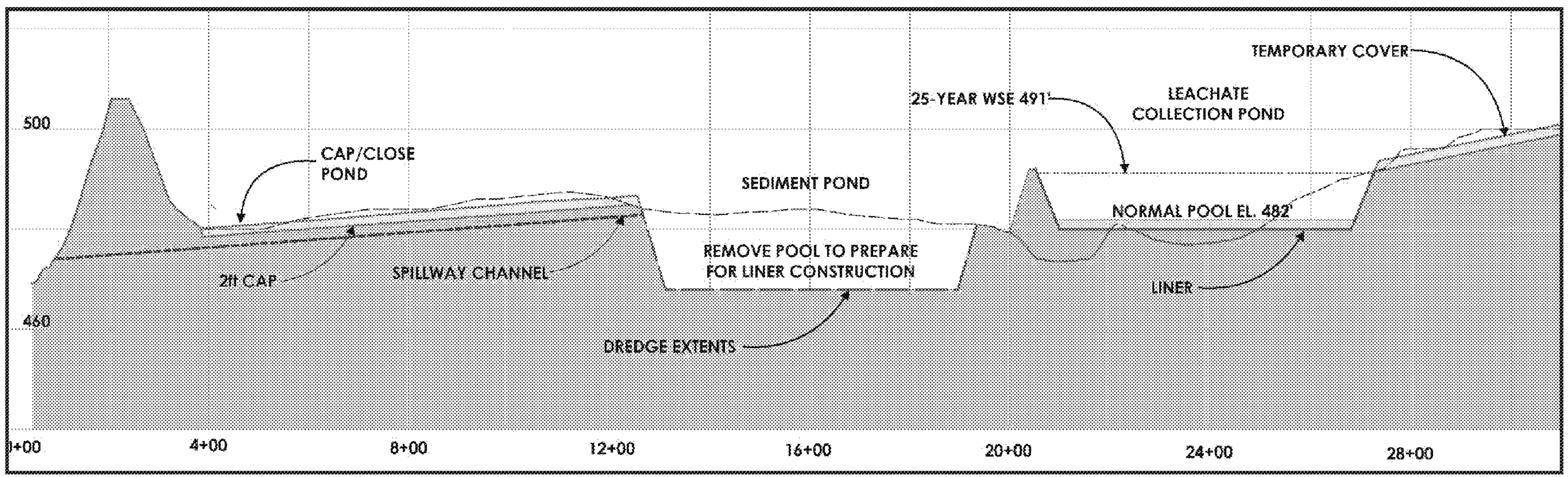
Phase A & B



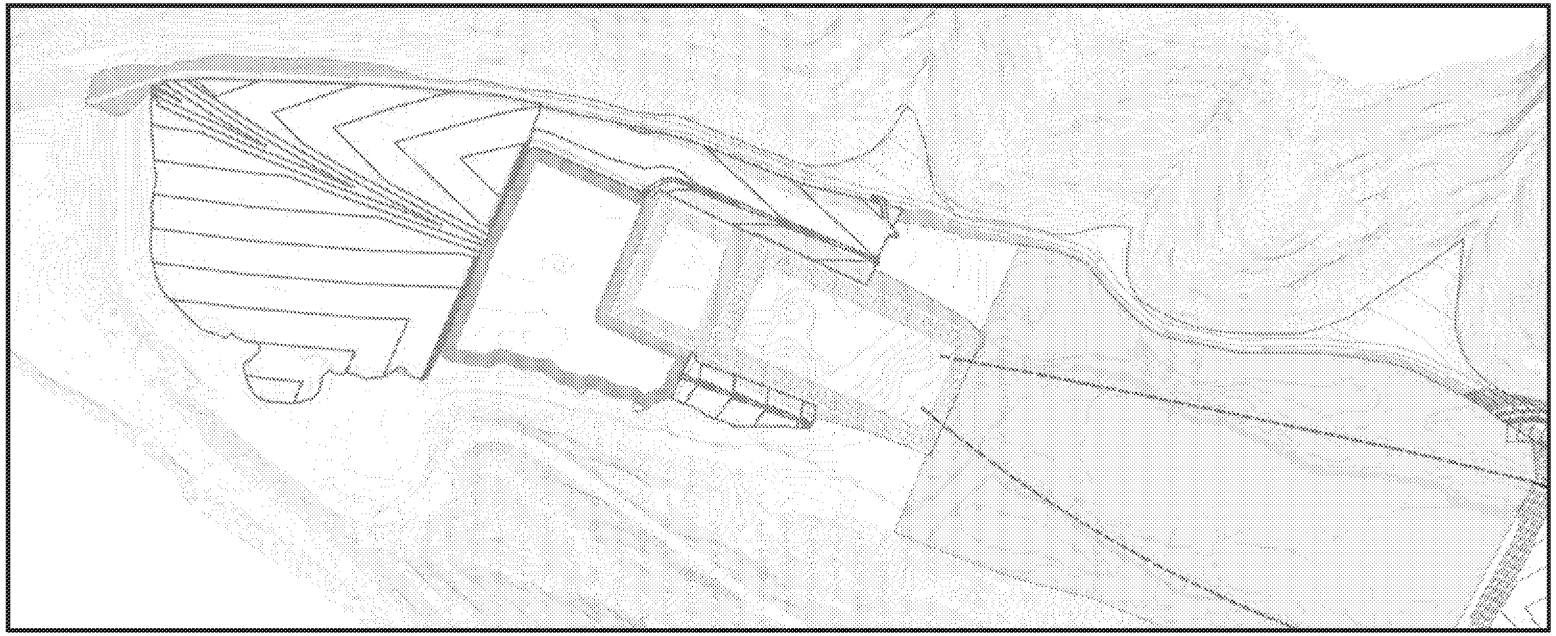

EXISTING ASH
500
CAP/CLOSE POND
SEDIMENT POND
10-YEAR WSE 479.7'
NORMAL POOL EL. 472'
2ft CAP
SPILLWAY CHANNEL
460
PHASE A DREDGE EXTENTS
0+00
4+00
8+00
12+00
16+00
20+00
24+00
28+00

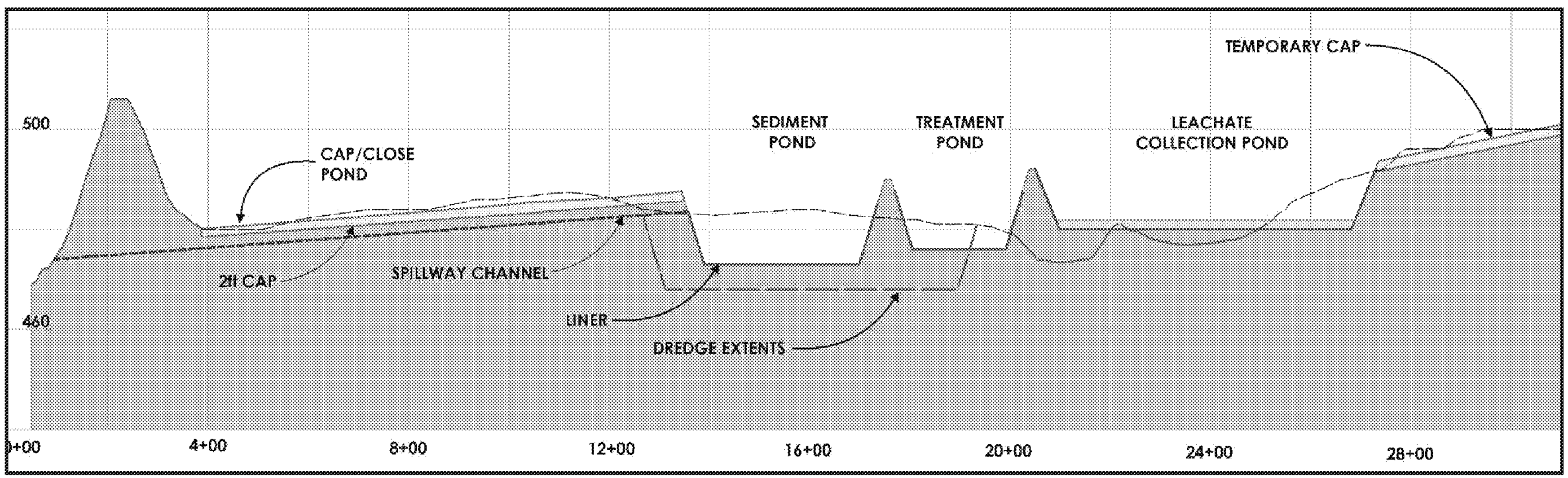
Phase C



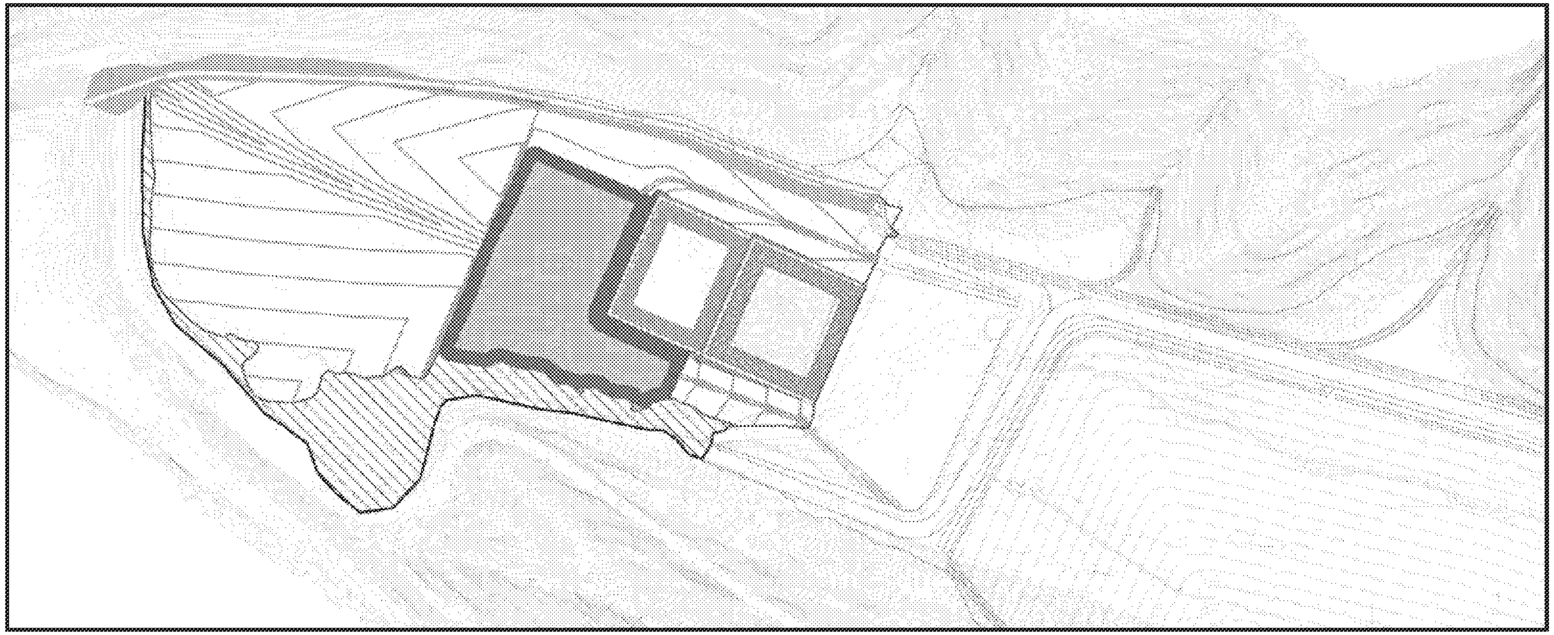

TEMPORARY COVER
25-YEAR WSE 491'
LEACHATE
COLLECTION POND
500
CAP/CLOSE
POND
SEDIMENT POND
NORMAL POOL EL. 482'
REMOVE POOL TO PREPARE
FOR LINER CONSTRUCTION
2ft CAP
SPILLWAY CHANNEL
LINER
460
DREDGE EXTENTS
0+00
4+00
8+00
12+00
16+00
20+00
24+00
28+00

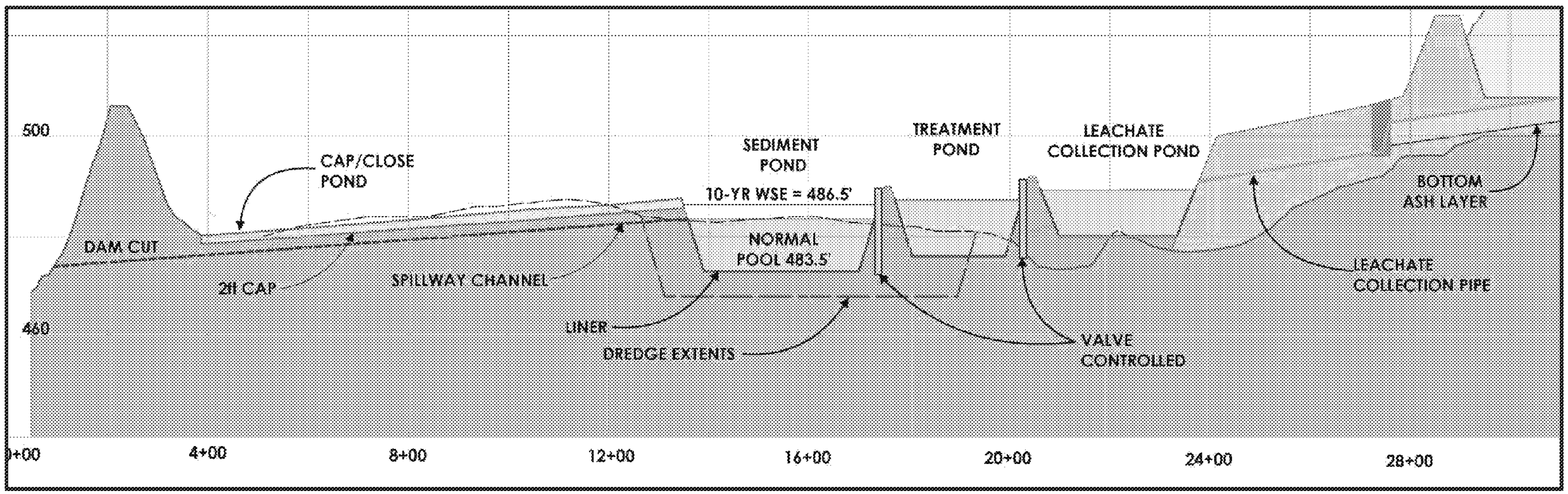
Phase D



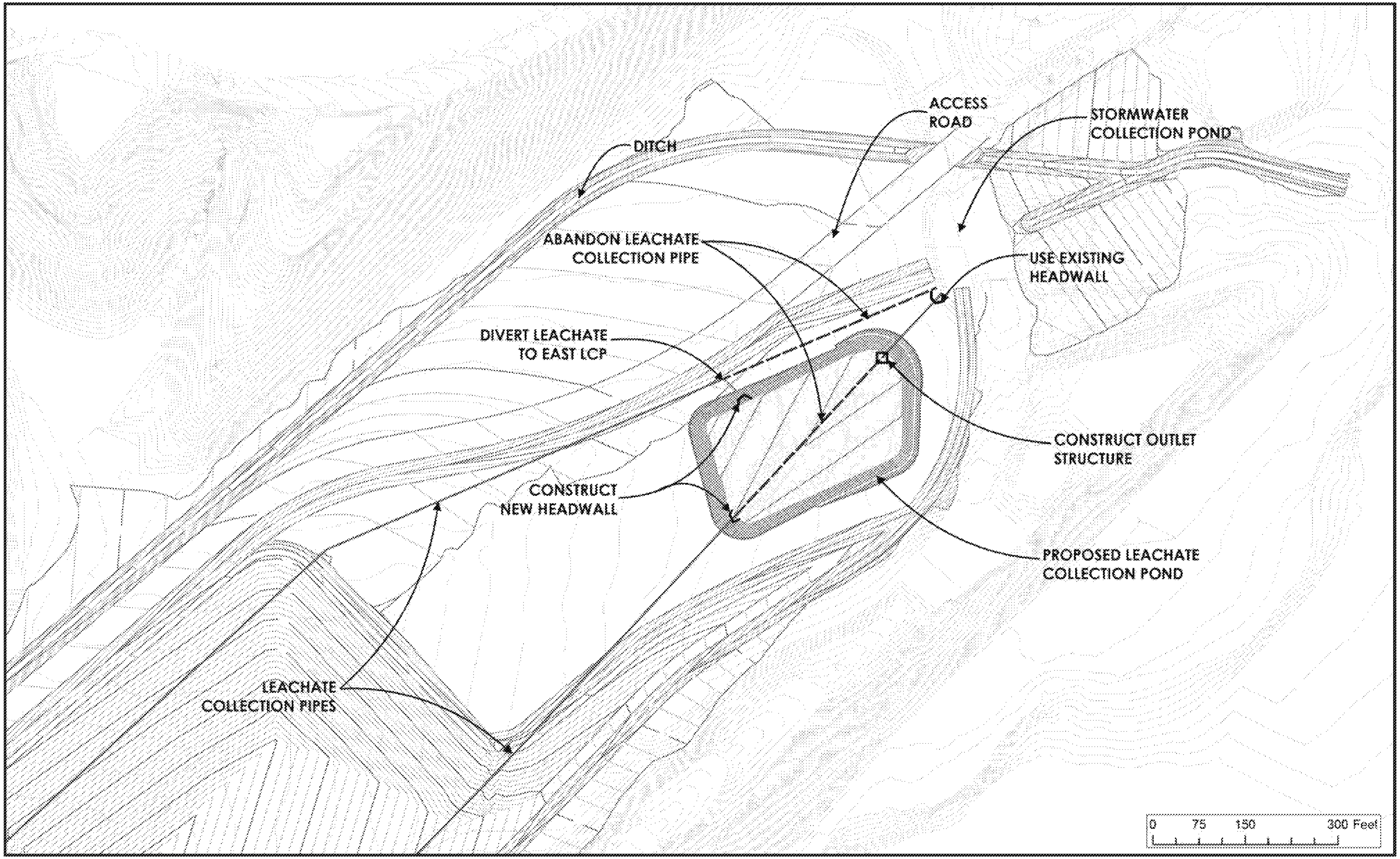

TEMPORARY CAP
500
CAP/CLOSE POND
SEDIMENT POND
TREATMENT POND
LEACHATE COLLECTION POND
2ft CAP
SPILLWAY CHANNEL
460
LINER
DREDGE EXTENTS
0+00
4+00
8+00
12+00
16+00
20+00
24+00
28+00

Final Configuration

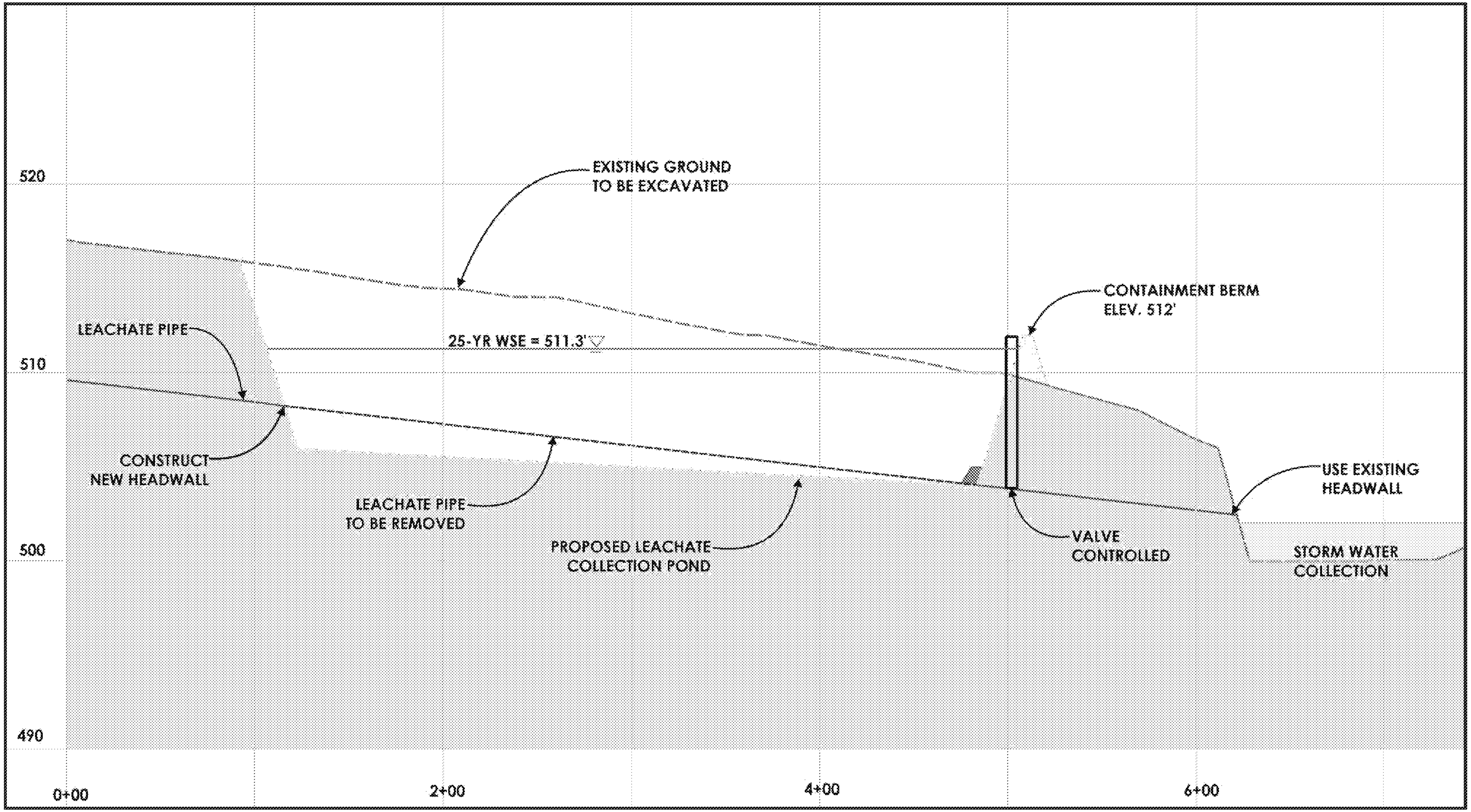




East Leachate Collection Pond



East Leachate Collection Pond



APPENDIX E – COMPLIANCE DOCUMENTATION

APPENDIX E1 – GROUNDWATER MONITORING SYSTEM

Stantec Consulting Services Inc.
11687 Lebanon Road, Cincinnati OH 45241

November 13, 2018
File: 175534018
Revision 1

Indiana-Kentucky Electric Corporation
3932 U.S. Route 23
P.O. Box 468
Piketon, Ohio 45661

RE: Groundwater Monitoring System
CCR Landfill, West Boiler Slag Pond, and Landfill Runoff Collection Pond
EPA Final Coal Combustion Residuals (CCR) Rule
Clifty Creek Station
Madison, Jefferson County, Indiana

1.0 PURPOSE

This letter documents Stantec's certification of the groundwater monitoring system designed and constructed by Applied Geology and Environmental Science, Inc. (AGES) for the Indiana-Kentucky Electric Corporation (IKEC) Clifty Creek Station's CCR Landfill, West Boiler Slag Pond (WBSP), and Landfill Runoff Collection Pond (LRCP). The EPA Final CCR Rule requires owners or operators of CCR landfills and surface impoundments to install a groundwater monitoring system as per 40 CFR 257.91.

2.0 GROUNDWATER MONITORING SYSTEM - REQUIREMENTS

The performance standard listed in 40 CFR 257.91(a) requires that the groundwater monitoring system consist of sufficient number of wells, installed at appropriate locations and depths, to yield groundwater samples from the uppermost aquifer that:

(1) Accurately represents the quality of background groundwater that has not been affected by leakage from a CCR unit, and

(2) Accurately represents the quality of groundwater passing the waste boundary of the CCR unit, by installing the downgradient monitoring system at the waste boundary ensuring detection of groundwater contamination in the uppermost aquifer. All potential contaminant pathways must be monitored.

In accordance with 40 CFR 257.91(b), the number, spacing, and depths of the monitoring system shall be determined based on site-specific technical information such as:

(1) Aquifer thickness, groundwater flow rate, groundwater flow direction including seasonal and temporal fluctuations in groundwater flow, and

(2) Saturated and unsaturated geologic units and fill materials overlying the uppermost aquifer, and materials comprising the confining unit defining the lower boundary of the

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uppermost aquifer, including, but not limited to, thicknesses, stratigraphy, lithology, hydraulic conductivities, porosities, and effective porosities.

40 CFR 257.91(c) states that the groundwater monitoring system must include the minimum number of monitoring wells necessary to meet the performance standards of 40 CFR 257.91(a), based on the site-specific information in 40 CFR 257.91(b). The groundwater monitoring system must consist of a minimum of one upgradient and three downgradient monitoring wells with additional monitoring wells as necessary to accurately represent the quality of background groundwater that has not been affected by leakage from the CCR unit and the quality of groundwater passing the waste boundary of the CCR unit.

The owner of multiple CCR units may install a single multiunit groundwater monitoring system to monitor multiple CCR units per Section 40 CFR 257.91(d). It must be equally as capable of detecting monitored constituents at the waste boundary of the CCR unit as the individual groundwater monitoring system defined in 40 CFR 257.91(a), (b), and (c) for each CCR unit based on number, spacing, and orientation of each CCR unit, hydrogeologic setting, site history, and engineering design of the CCR unit. If the owner or operator elects to install a multiunit groundwater monitoring system, and if the multiunit system includes at least one existing unlined CCR surface impoundment as determined by §275.71(a), and if at any time after October 19, 2015 the owner or operator determines in any sampling event that the concentrations of one or more constituents listed in appendix IV to this part are detected at statistically significant levels above the groundwater protection standard established under 40 CFR 257.95(h) for the multiunit system, then all unlined CCR surface impoundments comprising the multiunit groundwater monitoring system are subject to the closure requirements under §257.101(a) to retrofit or close.

40 CFR 257.91(e) states that the monitoring wells must be cased in a manner that maintains the integrity of the monitoring well borehole. The casing must be screened or perforated and packed with gravel or sand, where necessary, to enable collection of groundwater samples. The annular space above the sampling depth must be sealed to prevent contamination of samples and the groundwater.

3.0 SUMMARY OF FINDINGS

Stantec personnel reviewed the *Coal Combustion Residuals Regulation, Monitoring Well Installation Report (MWIR), Indiana-Kentucky Electric Corporation, Clifty Creek Station, Madison, Indiana* (AGES, October 2016, Revision 1.0 October 2018). Each of the four sections of 40 CFR 257.91, as shown above in Section 2.0 of this certification letter, is detailed below to evaluate

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compliance. The sections, tables, figures, and appendices detailed in the following paragraphs refer to the MWIR.

<u>40 CFR 257.91(a)</u>

Performance standard. *The groundwater monitoring system must consist of a sufficient number of wells, installed at appropriate locations and depths, to yield groundwater samples from the uppermost aquifer that:*

(1) Accurately represents the quality of background groundwater that has not been affected by leakage from a CCR unit, and

(2) Accurately represent the quality of groundwater passing the waste boundary of the CCR unit. The downgradient monitoring system must be installed at the waste boundary that ensures detection of groundwater contamination in the uppermost aquifer. All potential contaminant pathways must be monitored.

This standard is met if §§257.91(b) through (e) are met. §§257.91(b), (c), (d), and (e) are discussed below.

<u>40 CFR 257.91(b)</u>

The number, spacing, and depths of the monitoring systems shall be determined based on site-specific technical information such as:

(1) Aquifer thickness, groundwater flow rate, groundwater flow direction including seasonal and temporal fluctuations in groundwater flow, and

(2) Saturated and unsaturated geologic units and fill materials overlying the uppermost aquifer, and materials comprising the confining unit defining the lower boundary of the uppermost aquifer, including, but not limited to, thicknesses, stratigraphy, lithology, hydraulic conductivities, porosities, and effective porosities.

The geology and hydrogeology for each CCR unit is discussed based on historical data in Section 3.0. The uppermost aquifer for each is identified using subsurface stratigraphy and the hydrogeologic study report (AGES, 2007) performed to support the landfill permit. Generalized geologic cross-sections are included as Figures 3, 5, and 7 (AGES, 2018). Tables 4 and 5 are the

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summaries of the slug tests performed for the CCR Landfill and LRCP and the WBSP, respectively. The aquifer testing results performed in May 2016 are included in Appendix F.

Section 4.2 outlines the evaluation of the existing well and piezometer data to estimate groundwater depth in the uppermost aquifer and likely groundwater flow direction. Six additional geotechnical borings were performed in the CCR units per Section 4.3. One boring was located downgradient of the southwest end of the CCR Landfill and LRCP with three borings performed in background areas for the units. Two soil borings were performed at the WBSP. The soil borings were intended to obtain more detailed subsurface geology and to identify location, thickness, and composition, of the uppermost aquifer. Soil samples from three borings were the basis of the grain-size analyses used to design the monitoring well screens and filter packs for two background monitoring wells at the CCR Landfill and LRCP multiunit system and one monitoring well at the WBSP (Section 4.4 and Appendix A).

<u>40 CFR 257.91(c)</u>

> *the groundwater monitoring system must include the minimum number of monitoring wells necessary to meet the performance standards of 40 CFR 257.91(a), based on the site-specific information in 40 CFR 257.91(b). The groundwater monitoring system must consist of a minimum of one upgradient and three downgradient monitoring wells with additional monitoring wells as necessary to accurately represent the quality of background groundwater that has not been affected by leakage from the CCR unit and the quality of groundwater passing the waste boundary of the CCR unit.*

Section 4.6 outlines the monitoring well networks for each CCR unit to meet this requirement.

For the CCR Landfill and LRCP multiunit system, six monitoring wells were installed in 2015. Section 3.1 describes the underlying soil stratigraphy and hydrogeologic conditions of the combined unit. A groundwater divide is located in the valley where the CCR Landfill is located with groundwater flowing to the northeast or southwest within the confined bedrock valley. At the southwestern end of the combined unit, three downgradient monitoring wells were installed. Three monitoring wells were installed outside the hydrologic influence of the combined unit and the WBSP to serve as background monitoring wells. Section 4.6.1 and Table 2 lists the eight monitoring wells in the CCR network as three downgradient and six background (or background/intermediate). Figures 1, 5, 6, and 10 show the groundwater monitoring well locations for the CCR Landfill and LRCP multiunit system.

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The WBSP's groundwater monitoring network is described in Section 4.6.2 and Table 3. Ten monitoring wells were installed around the WBSP perimeter in late 2015 and early 2016. Three monitoring wells are noted as upgradient, while seven are listed as downgradient. Figures 7, 8, and 9 show the groundwater monitoring well locations of the WBSP.

As discussed in Section 5.0, slug testing was performed in one background well, one monitoring well at the CCR Landfill and LRCP multiunit system, and in three monitoring wells at the WBSP. The testing was performed to estimate saturated hydraulic conductivity of the uppermost aquifer. The test results are in Tables 4 and 5 with supporting data in Appendix F.

40 CFR 257.91(d)

> *The owner of multiple CCR units may install a single multiunit groundwater monitoring system to monitor multiple CCR units per Section 40 CFR 257.91(d). It must be equally as capable of detecting monitored constituents at the waste boundary of the CCR unit as the individual groundwater monitoring system defined in 40 CFR 257.91(a), (b), and (c) for each CCR unit based on number, spacing, and orientation of each CCR unit, hydrogeologic setting, site history, and engineering design of the CCR unit. If the owner or operator elects to install a multiunit groundwater monitoring system, and if the multiunit system includes at least one existing unlined CCR surface impoundment as determined by §275.71(a), and if at any time after October 19, 2015 the owner or operator determines in any sampling event that the concentrations of one or more constituents listed in appendix IV to this part are detected at statistically significant levels above the groundwater protection standard established under 40 CFR 257.95(h) for the multiunit system, then all unlined CCR surface impoundments comprising the multiunit groundwater monitoring system are subject to the closure requirements under §257.101(a) to retrofit or close.*

Section 2.1 describes the site history and hydrogeologic setting of the CCR Landfill and LRCP. The two CCR units are located within an eroded bedrock channel confined as described in Section 3.1. The area initially served as a fly ash pond prior to development of a Type III CCR Landfill in 1988. Under the current Indiana Department of Environmental Management (IDEM) permit, the two CCR units are now approximately 208 acres with 109 acres designated for the CCR Landfill and 99 acres at the southwest end identified as the LRCP. The CCR Landfill and LRCP are served by a multiunit groundwater monitoring system that encompasses the historic fly ash pond footprint.

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40 CFR 257.91(e)

> *The monitoring wells must be cased in a manner that maintains the integrity of the monitoring well borehole. The casing must be screened or perforated and packed with gravel or sand, where necessary, to enable collection of groundwater samples. The annular space above the sampling depth must be sealed to prevent contamination of samples and the groundwater.*

The monitoring well installation and development for the three CCR units is discussed in Section 4.5. Section 4.4 discusses the design of pre-packed well screens used for the construction of the monitoring wells. The two sections discuss the two-inch diameter slotted Schedule 40 PVC screen, 0.40-millimeter quartz sand filter pack, steel casing during well placement, and the four-foot-thick annular bentonite seal above the filter pack in each well. Monitoring well logs are detailed in Appendix B. Well construction for the monitoring networks of each CCR unit is detailed in terms of well ID, locations, elevations, and date of installation in Tables 2 and 3.

The attached MWIR demonstrates that the groundwater monitoring system was designed and constructed to meet the requirements set forth in 40 CFR 257.91(a), (b), (c), (d), and (e).

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4.0 QUALIFIED PROFESSIONAL ENGINEER CERTIFICATION

I, Stan A. Harris, being a Professional Engineer in good standing in the State of Indiana, do hereby certify, to the best of my knowledge, information, and belief:

1. that the information contained in this certification is prepared in accordance with the accepted practice of engineering;
2. that the information contained herein is accurate as of the date of my signature below; and
3. that the groundwater monitoring systems for the IKEC Clifty Creek Station's CCR Landfill, West Boiler Slag Pond, and Landfill Runoff Collection Pond have been designed and constructed to meet the requirements specified in 40 CFR 257.91(a), (b), (c), (d), and (e).

SIGNATURE ______________ DATE 11/13/18

ADDRESS: Stantec Consulting Services Inc.
11687 Lebanon Road
Cincinnati, Ohio 45241

TELEPHONE: (513) 842-8200

ATTACHMENTS: Applied Geology and Environmental Science, Inc. (AGES) (2018). Coal Combustion Residuals Regulation, Monitoring Well Installation Report, Indiana-Kentucky Electric Corporation, Clifty Creek Station, Madison, Indiana. October 2016. Revision 1.0. October.

STAN A. HARRIS
REGISTERED
No.
PE-19700150
STATE OF
INDIANA
PROFESSIONAL ENGINEER

11/13/18

AGES
Applied Geology And Environmental Science, Inc.

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Clinton, PA 15026
www.appliedgeology.net
P 412. 264. 6453
F 412. 264. 6567

COAL COMBUSTION RESIDUALS REGULATION MONITORING WELL INSTALLATION REPORT

INDIANA-KENTUCKY ELECTRIC CORPORATION
CLIFTY CREEK STATION
MADISON, INDIANA

OCTOBER 2016

Revision 1.0 November 2018

Prepared for:

INDIANA-KENTUCKY ELECTRIC CORPORATION (IKEC)

By:

APPLIED GEOLOGY AND ENVIRONMENTAL SCIENCE, INC.

COAL COMBUSTION RESIDUALS REGULATION
MONITORING WELL INSTALLATION REPORT
INDIANA-KENTUCKY ELECTRIC CORPORATION
CLIFTY CREEK STATION
MADISON, INDIANA

OCTOBER 2016

Revision 1.0 November 2018

Prepared for:

INDIANA-KENTUCKY ELECTRIC CORPORATION (IKEC)

Prepared By:

Applied Geology and Environmental Science, Inc.

Diane E. Miller, P.G.
Senior Geologist

Robert W. King, P.G.
President/Chief Hydrogeologist

COAL COMBUSTION RESIDUALS REGULATION
MONITORING WELL INSTALLATION REPORT
INDIANA-KENTUCKY ELECTRIC CORPORATION
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INDIANA-KENTUCKY ELECTRIC CORPORATION
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MADISON, INDIANA

1.0 INTRODUCTION

On December 19, 2014, the United States Environmental Protection Agency (U.S. EPA) issued their final Coal Combustion Residuals (CCR) regulation which regulates CCR as a non-hazardous waste under Subtitle D of Resource Conservation and Recovery Act (RCRA) and became effective six (6) months from the date of its publication (April 17, 2015) in the Federal Register. The rule applies to new and existing landfills, and surface impoundments used to dispose of or otherwise manage CCR generated by electric utilities and independent power producers. Because the rule was promulgated under Subtitle D of RCRA, it does not require regulated facilities to obtain permits, does not require state adoption, and cannot be enforced by U.S. EPA. The only compliance mechanism is for a state or citizen group to bring a RCRA suit in federal district court against any facility that is alleged to be in non-compliance with the new requirements.

All CCR landfills and CCR surface impoundments (including inactive impoundments unless they close within three (3) years from the promulgation date of the rule) are subject to new, and typically more stringent than current, state requirements for groundwater monitoring and, if necessary, corrective action. Within 30 months after the date of publication (April 17, 2015) in the Federal Register, all existing CCR landfills and existing CCR surface impoundments must have installed groundwater monitoring systems, initiated a groundwater detection monitoring program, and begun assessing groundwater monitoring data to evaluate groundwater quality at each CCR unit.

In March 2015, the Indiana-Kentucky Electric Corporation (IKEC) contracted with Applied Geology and Environmental Science (AGES), Inc. to identify upgrades in the groundwater monitoring program for the Clifty Creek Station located in Madison, Indiana that would be necessary for compliance with the CCR regulation. Based on a review of available site data and the CCR regulation, AGES, IKEC and staff from Stantec worked together to develop a detailed scope of work and schedule for the groundwater monitoring system upgrades. Field work on the project (monitoring well installation and development) was conducted from November 2015 through January 2016.

Presented below are a discussion of the CCR units identified at the station, site geology and hydrogeology, and the well installation and development program.

2.0 BACKGROUND

The Clifty Creek Station, located in Madison, Indiana, is a 1,304-megawatt (MW) coal-fired generating plant operated by the IKEC, a subsidiary of the Ohio Valley Electric Company (OVEC). The Clifty Creek Station has six (6) 217.26-MW generating units and has been in operation since 1955. Beginning in 1955, ash products were sluiced to disposal ponds located in the plant site. During the course of plant operations, CCRs have been managed and disposed of in various units at the station. There are three (3) CCR units at the Clifty Creek Station (Figure 1):

- Type I Residual Waste Landfill (Type I Landfill);
- Landfill Runoff Collection Pond (LRCP); and,
- West Boiler Slag Pond (WBSP).

Information regarding the history and hydrogeology of each unit was obtained by reviewing several historic documents listed in Section 7.0 of this report.

2.1 Type I Residual Waste Landfill and Landfill Runoff Collection Pond

The active Type I Landfill occupies an approximately 200-acre area situated within an eroded bedrock channel. A total of 109 acres were approved as a Type I residual waste landfill by the Indiana Department of Environmental Management (IDEM) in 2007. The remaining 91 acres consist of the LRCP located at the southwest end of the Type I Landfill (Figures 1 and 2).

Beginning in 1955, ash products were sluiced to disposal ponds located in the bedrock channel at the plant site. To allow for more disposal capacity, an on-site fly ash pond was developed into a Type III residual landfill in 1988. All required permits for the Type III Residual Waste Landfill (Type III Landfill) were obtained from IDEM. The Type III Landfill was permitted to be constructed, and to serve as closure for the historic fly ash ponds. The Type III Landfill is located at the northeast end of the bedrock channel and went operational in 1991.

In 2013, IDEM approved IKEC's request to upgrade the Type III Landfill to a Type I residual waste landfill (Type I Landfill). As part of the process, the Type III Landfill was closed and the Type I Landfill was designed and constructed to serve as the cap for the closed Type III Landfill. The Type I Landfill is completely separated from the closed Type III Landfill by a geosynthetic liner and a compacted clay liner (Figure 3).

The LRCP is an unlined pond located at the southern edge of the station. It is bordered by the Type I Landfill to the north, natural grade to the east and west, and by a dam to the south that runs along the bank of the Ohio River. Approximately 508 acres of both landfill contact water and stormwater runoff drain to the LRCP (Stantec 2016). The base of the LRCP consists of historic hydraulically-placed fly ash. The LRCP does not receive CCR and any CCR within the

LRCP is not being actively managed. Therefore, the LRCP is identified as an inactive unit under the CCR Rule.

2.2 West Boiler Slag Pond

The WBSP currently serves as a settling facility for sluiced boiler slag produced at the plant. In addition to the process flows from the plant, approximately 510 acres drain to the WBSP. The pond is formed by natural grade to the north, east and west and a southern dike that runs along the bank of the Ohio River (Figures 1 and 2).

3.0 GEOLOGY & HYDROGEOLOGY

The site lies in the Central Lowland Physiographic Province along the western flanks of the Cincinnati Arch and within the Central Stable Region. The stratigraphic sequence in the regional area consists of widespread discontinuous layers of Quaternary deposits of alluvial and glacial origin overlying sedimentary rocks generally consisting of limestones, dolomites and interbedded shale. The exposed sedimentary rocks range in age from Mississippian to Ordovician. The Quaternary deposits are largely of glacial origin and consist of loess, till and outwash. Glacial outwash is present in nearly all of the stream valleys north of and including the Ohio River valley. The outwash is covered, in some cases, by a veneer of recent alluvial deposits from active streams.

Unconsolidated alluvial sediments deposited along the Ohio River valley, near or adjacent to the river constitute the major aquifer of the region. These deposits are normally found only within the Ohio River valley and the tributary streams north and northeast of the river. Wells installed in this aquifer typically yield 100 to 1,000 gallons per minute (gpm) depending upon their location and construction. The Ohio River valley is incised into Ordovician bedrock. The low permeability bedrock forms the lateral and underlying confinement to the aquifer.

3.1 Type I Residual Waste Landfill and Landfill Runoff Collection Pond

Based on information in the Hydrogeologic Study Report (AGES 2007), bedrock beneath the Type I Landfill & LRCP and the closed Type III Landfill consists of impermeable limestone and shale of the Ordovician Dillsboro formation, which is overlain by approximately 20 to 35 feet of gray clay. The gray clay is directly overlain by fly ash that had been historically hydraulically placed in the area. Generalized geologic cross-sections are presented in Figures 3 through 5. A limestone ridge known as the Devil's Backbone runs northeast to southwest along the length of the Type I Landfill & LRCP and the closed Type III Landfill. The Devil's Backbone acts as an impermeable barrier that forces groundwater passing beneath both of the landfills to flow either toward the northeast or toward the southwest. A detailed hydrogeologic study determined that a groundwater flow divide is present near the northeast end of the bedrock channel and that all groundwater beneath the active Type I Landfill flows toward the southwest (AGES 2007).

An aquifer does not exist beneath the Type I Landfill. Therefore, alluvial deposits located southwest of the LRCP are designated as the uppermost aquifer for the Type I Landfill & LRCP. These alluvial deposits consist of approximately 10 to 15 feet of silty clay, overlying various depths of fine to medium grained sand with gravel, silt and clay (Figure 5). The alluvial deposits overlay layers of clay and clayey gravel, which overlay limestone bedrock of the Dillsboro Formation at depths ranging from 15 to 90 feet below ground surface (bgs).

Based on historic aquifer testing conducted at the site, the upper silty clay deposits are relatively impermeable, do not yield adequate quantities of water to wells, and are considered to be an aquiclude. The lower fine to medium grained sand with gravel, silt and clay deposits are considered to be an unconfined or possibly semi-confined aquifer and are therefore designated as the uppermost aquifer at the Landfill and LRCP.

3.2 West Boiler Slag Pond

The WBSP is formed by natural grade to the north, east and west and a southern dike that runs along the bank of the Ohio River (Figures 1 and 2). A generalized geologic cross-section of this unit is presented in Figure 7. The Devil's Backbone borders the northern side of the WBSP.

Based on information from historical soil boring data, there appears to be a layer of fly ash, up to five (5) feet thick in the northeastern portion of the WBSP. Below the ash and extending to the south and west beneath the remainder of the pond, the WBSP is underlain by alluvial deposits consisting of layers of silty clay, sandy silt and silty sand ranging from approximately 16 feet bgs on the northwest side of the WBSP (closest to the Devil's Backbone) to approximately 90 feet bgs on the southeast side of the WBSP (closest to the Ohio River). These alluvial deposits sit directly on top the bedrock. Review of logs from historic soil borings indicated that a layer of silty clay extends from directly beneath the WBSP to an approximate elevation of 425 feet msl. Historic boring logs indicated that the clay is underlain by a layer of silt with fine sand that becomes more coarse-grained further to the north & northeast. This layer was determined to be the uppermost aquifer beneath the WBSP. Groundwater beneath the WBSP flows from the northwest to the southeast toward the Ohio River (Figure 8).

4.0 GROUNDWATER MONITORING SYSTEM DESIGN & INSTALLATION

4.1 Groundwater Monitoring System Design

Section §257.91 of the CCR regulation states that the groundwater monitoring system for each CCR unit must contain a sufficient number of wells, installed at appropriate locations and depths, to yield groundwater samples from the uppermost aquifer that accurately represent the quality of background groundwater that has not been affected by leakage from a CCR unit and, accurately represent the quality of groundwater passing the waste boundary of the CCR unit.

Section §257.91(c) requires that the groundwater monitoring system for each CCR unit includes a minimum of one (1) upgradient/background monitoring well to accurately represent the quality of background groundwater that has not been affected by leakage from the CCR unit, and a minimum of three (3) downgradient monitoring wells located as close as practicable to the waste boundary to accurately represent the quality of groundwater passing the waste boundary of the CCR unit.

4.2 Data Review and Evaluation of Existing Wells and Piezometers

To begin the process, AGES reviewed available data for any existing monitoring wells and piezometers that had been installed around each CCR unit. The purpose of this data review was to identify the approximate depth to the uppermost aquifer for each CCR unit and to evaluate likely groundwater flow direction to ensure that the new CCR groundwater monitoring network contained the required number of upgradient/background and downgradient monitoring wells.

4.2.1 Type I Residual Waste Landfill and Landfill Runoff Collection Pond

In June 2015, water levels were collected from all of the existing monitoring wells and piezometers around the Type I Landfill and LRCP. These water levels confirmed that groundwater beneath the Type I Landfill and LRCP flows to the southwest toward the Ohio River.

Due to the geologic setting of the Type I Landfill and LRCP, there were no suitable upgradient groundwater monitoring locations and upgradient monitoring wells were not installed. To meet the monitoring requirements of the CCR regulation IKEC opted to install one (1) background monitoring well in an area outside the influence of the Landfill (Figure 9).

The Type I Landfill is the subject of an on-going monitoring program for the Indiana Department of Environmental Management (IDEM). Several downgradient monitoring wells are included in the IDEM monitoring program but upgradient monitoring wells were not installed. To ensure consistency in monitoring well construction for all of the wells in the CCR groundwater monitoring network for the Type I Landfill and LRCP, IKEC opted to install all new monitoring wells for the groundwater monitoring network (Figure 10).

4.2.2 West Boiler Slag Pond

In June 2015, water levels were collected from all existing monitoring wells and piezometers around the WBSP. These water levels indicated that groundwater flow beneath the WBSP was from the northwest to the south/southeast toward the adjacent Ohio River.

No previous groundwater monitoring program had been conducted at the WBSP and the existing monitoring wells and piezometers had not been properly constructed to monitor groundwater quality in the uppermost aquifer beneath the WBSP. Therefore, IKEC opted to install new monitoring wells around the WBSP to meet the requirements of the CCR regulation (Figure).

4.3 **Soil Boring Installation**

At the WBSP, most of the existing monitoring wells and piezometers were not screened in the uppermost aquifer. In addition, no background/upgradient wells had previously been installed for the Type I Landfill and LRCP. To obtain geologic information specific to the target areas of the aquifers to be monitored at the Type I Landfill and LRCP and to locate suitable locations in which to install background/upgradient wells for the Type I Landfill and LRCP, IKEC conducted several borings in July 2015 (Figure 1). One (1) soil boring (Downgradient SW) was conducted downgradient of the southwest end of the Type I Landfill and LRCP and three (3) soil borings (BKG-1, BKG-2 and BKG-3) were conducted in background areas. Two (2) soil borings (WAP-1 and WAP-2) were also conducted at the WBSP (Figure 1).

The purpose of these borings was to obtain a more detailed description of the subsurface geology and to identify the location, size and composition of the uppermost aquifers at the Type I Landfill and LRCP and WBSP. Representative samples of the units identified as the uppermost aquifer in borings BKG-2 and BKG-3 at the Type I Landfill and LRCP and WAP-2 at the WBSP were collected and sent to a geotechnical soil laboratory for grain-size analysis to provide data to be used to design the groundwater monitoring system. Groundwater was not encountered in Type I Landfill and LRCP boring BKG-1 or in WBSP boring WAP-1. Therefore samples were not collected from these borings for analysis.

4.4 **Grain Size Analysis and Monitoring Well Design**

The CCR regulation requires that unfiltered groundwater samples be submitted for laboratory analysis of Appendix III and IV constituents. According to the preamble to the rule, the unfiltered sample requirement assumes that groundwater samples with a turbidity of less than 5 NTUs can be obtained from a properly designed monitoring well. The proper design of the sand pack and well screen in each well is therefore critical to obtaining representative groundwater samples.

To support CCR well design, representative samples were collected of material from the uppermost aquifers at the Type I Landfill and LRCP, and the WBSP. These soil samples were submitted to a geotechnical laboratory for grain-size analysis per American Society for Testing and Materials (ASTM) Methods D421 and D422. The results of the grain size analyses were used to design the well screens and filter packs for the monitoring wells. The laboratory reports for the grain size analyses are included in Appendix A.

In accordance with U.S. EPA monitoring well design guidelines (U.S. EPA, 1991), the grain size of the filter pack was chosen by multiplying the 70% retention (or 30% passing) size of the formation, as determined by the grain size analysis, by a factor of 3 (for fine uniform formations) to 6 (for coarse, non-uniform formations). Table 1 summarizes the results of the grain-size analysis and the 70% retention size for each of the samples collected from each boring.

To reduce turbidity as much as possible, pre-packed well screens were selected for use in the monitoring wells. The 2-inch diameter 0.01" slotted Schedule 40 PVC pre-packed screens are designed specifically for sampling metals in groundwater. The pre-packed well screens were constructed using an inner filter pack consisting of 0.40 mm clean quartz filter sand between two layers of food-grade plastic mesh to reduce sample turbidity by filtering out smaller particles than is possible with standard filter packed wells and prepack screens. No metal components were used in the construction of the pre-packed well screens, thus eliminating potential interference with metals analysis.

4.5 Monitoring Well Installation and Development

Well installation and development at the Clifty Creek Station were conducted from November 2015 through January 2016 by Bowser Morner, Inc., under the supervision of AGES. During the field work, AGES oversaw all drilling activities, prepared lithologic descriptions of all soil, and took detailed field notes for all of the work.

To comply with the CCR regulation requiring the groundwater monitoring system for each CCR unit to contain a minimum of one (1) background/upgradient and three (3) downgradient monitoring wells, six (6) wells were installed at the Type I Landfill and LRCP and 10 monitoring wells were installed at the WBSP. Details regarding monitoring well installation are presented below.

4.5.1 <u>Monitoring Well Installation</u>

New monitoring wells at the Type I Landfill and LRCP were installed using either rotary vibratory or hollow stem auger drilling methods. With either method, the drill bit was simultaneously pushed down and rotated. The drill head was advanced in 10-foot runs through an 8-inch metal casing to keep the borehole open. Continuous soil samples were obtained from the entire length of each 10-foot run and were logged by the AGES geologist (Appendix B). A steel casing was installed as each boring was advanced to keep the borehole open during well installation.

When using hollow stem augers, continuous split-spoon samples were collected and were logged by the AGES geologist (Appendix B). The augers were used to advance each boring to the desired depth and the augers were kept in place to keep the borehole open during well installation. The augers were removed as well installation progressed.

Once each borehole was advanced to the desired depth, a 5-foot or 10-foot pre-packed well screen was set into the borehole depending on the geologic conditions encountered in each borehole. An outer filter pack consisting of 0.40 mm clean quartz sand was installed directly around the pre-packed well screen. The sand was placed as the metal casing was pulled back in one (1)- to two (2)- foot increments to reduce caving effects and ensure proper placement of the filter pack. The filter pack extended two (2)-feet above the top of the screen.

A four (4)-foot thick annular bentonite seal was installed above the filter pack in each well. Once in place, the bentonite seal was allowed to hydrate before the remainder of the annular space around each monitoring well was backfilled using a grout consisting of portland cement and bentonite. Each monitoring well was completed with either an above-ground protective steel casing or a flush-mount steel well cover and a locking well cap. Following installation, each monitoring well was surveyed for elevation and location by IKEC personnel.

Well construction details for all of the wells installed at the Type I Landfill and LRCP, and WBSP are presented in Tables 2 & 3, respectively. All boring and well logs are included in Appendix B.

4.5.2 Monitoring Well Development

Well development was initiated at least 48 hours after installation of each of the monitoring wells. Development consisted of alternating surging and pumping with a submersible pump or bailing in low yielding wells. During development of the monitoring wells, field parameters including temperature, specific conductance, pH and turbidity were recorded at regular intervals. Development continued until each parameter stabilized and turbidity was less than 5 NTUs. Well development data is included in Appendix C.

4.6 Groundwater Monitoring Networks

To comply with the CCR regulation, each monitored CCR Unit must have a groundwater monitoring network consisting of a minimum of one (1) upgradient/background monitoring well and a minimum of three (3) downgradient monitoring wells installed as close as practicable to the waste boundary. A discussion of the CCR monitoring network for each unit is presented below.

4.6.1 Type I Residual Waste Landfill and Landfill Runoff Collection Pond

In November and December 2015, six (6) monitoring wells were installed at the Type I Landfill and LRCP (Figures 9 and 10).

Three (3) monitoring wells (CF-15-07, CF-15-08 and CF-15-09) were installed downgradient of the Type I Landfill and LRCP (Figure 10). Based on exploratory soil borings and historical data, there were no suitable upgradient locations for the Type I Landfill and LRCP. Therefore, CF-15-04 was installed outside the hydrologic influence of the Type I Landfill to serve as the required background monitoring well. In addition, CF-15-06 was installed to serve as an additional background monitoring well and CF-15-05 was installed as a background/intermediate monitoring well to ensure groundwater from the WBSP is not impacting groundwater at CF-15-06. The locations of the background wells are shown on Figure 9.

The Devils Backbone is a limestone ridge that trends northeast-southwest along the southern side of the Type I Landfill and LRCP. This ridge acts as an impermeable barrier separating groundwater flowing beneath the Type I Landfill and LRCP from groundwater flowing beneath the WBSP. Therefore, the upgradient WBSP wells WBSP-15-01 and WBSP-15-02 were also included as background wells for the Type I Landfill and LRCP groundwater monitoring network.

Table 2, and Figures 9 and 10 present the construction information and locations of the monitoring wells in the Type I Landfill and LRCP groundwater monitoring network. The review of historic data and groundwater levels measured from each well in January, March and May 2016, indicated that groundwater beneath the Type I Landfill and LRCP flows toward the southwest toward the Ohio River. Groundwater levels for January, March and May 2106 are included in Appendix D. Groundwater flow maps for January, March and May 2016 are included in Appendix E.

4.6.2 West Boiler Slag Pond

Table 2 and Figure 8 present the construction information and locations of the monitoring wells in the WBSP groundwater monitoring network. In accordance with the minimum requirements of the CCR regulation, three (3) monitoring wells were installed upgradient of the WBSP (WBSP-15-01, WBSP-15-02 and WBSP-15-03) and seven (7) monitoring wells (WBSP-15-04 through WBSP-10) were installed downgradient of the WBSP.

Based on groundwater levels measured from each well in January, March and May 2016, groundwater beneath the WBSP flows from the northwest to the southeast toward the Ohio River. Groundwater levels for January, March and May 2106 are included in Appendix D. Groundwater flow maps for January, March and May 2016 are included in Appendix E.

5.0 AQUIFER TESTING

In May 2016, aquifer testing was conducted on one (1) background well (CF-15-04), one (1) Type I Landfill and LRCP well (CF-15-08), and three (3) WBSP wells (WBSP-15-02, WBSP-15-06 and WBSP-15-07) to obtain data to calculate the saturated hydraulic conductivity (K) for the uppermost aquifer beneath each unit. Both rising and falling head slug tests were performed on each well.

The falling head tests were performed by lowering a solid slug with a known volume, into the water column of the well and recording the drop in head over time. The rising head tests were performed by removing the solid slug and recording the rise in head over time. The change of head over time was recorded using a data logger and pressure transducer. Dedicated rope was used to lower the slug into each well and the slug was decontaminated between wells using the procedures specified in the Groundwater Monitoring Program Plan (GMPP) for the Clifty Creek Station. Slug testing was performed after well development and the completion of three (3) rounds of groundwater sampling.

The slug test data were evaluated using AQTESOLV, a commercially available software package. Data from each monitoring well were analyzed using both the Bouwer-Rice and Hvorslev slug test solutions which are straight-line analytical techniques commonly used to analyze rising and falling head slug test data. The AQTESOLV results for each well are presented in Appendix E.

Slug test results for the Type I Landfill and LRCP, and WBSP are summarized on Tables 4 and 5, respectively. The K for the background well CF-15-04 is 1.51×10^{-3} centimeters per second (cm/sec). The K for well CF-15-08 at the Type I Landfill and LRCP is 2.44×10^{-3} cm/sec. The mean K for the uppermost aquifer beneath the WBSP is 9.44×10^{-3} cm/sec.

6.0 CONCLUSIONS

To meet the requirements of the CCR regulation, new groundwater monitoring networks were installed at the Type I Landfill and LRCP and the WBSP. Based on available historic data and exploratory soil borings, the following units were identified as the uppermost aquifer at each CCR unit:

- **Type I Landfill and LRCP:** Historic data identified alluvial deposits located southwest of the Type I Landfill and LRCP as the uppermost aquifer. Based on historic data and soil borings conducted during this investigation, depths to these deposits range from 15 to 40 feet bgs.

- **West Boiler Slag Pond:** The WBSP is underlain by alluvial deposits consisting of layers of silty clay, sandy silt and silty sand ranging from approximately 16 feet bgs on the northwest side of the WBSP (closest to the Devil's Backbone) to approximately 90 feet bgs on the southeast side of the WBSP (closest to the Ohio River). Soil and well borings indicated that a layer of gray silt with fine sand, becoming more coarse-grained further to the north & northeast, located at an elevation of approximately 425 feet msl is the uppermost aquifer beneath the WBSP.

To meet the monitoring network requirements of the CCR regulation, six (6) monitoring wells were installed at the Type I Landfill and LRCP, and 10 monitoring wells were installed around the WBSP.

Following installation, development, and three (3) rounds of groundwater sampling, slug testing was conducted on two (2) monitoring wells at the Type I Landfill and LRCP, and three (3) monitoring wells at the WBSP. Data from the slug testing was used to calculate the mean K of the uppermost aquifer at the Landfill and LRCP, and beneath the WBSP. The K for the Type I Landfill and LRCP is 2.44×10^{-3} cm/sec and the mean K for the uppermost aquifer beneath the WBSP is 9.44×10^{-3} cm/sec.

To meet the monitoring requirements of the CCR regulation, the groundwater monitoring networks at each of the two (2) CCR units at the Clifty Creek station will be sampled in accordance with the GMPP.

7.0 REFERENCES

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TABLES

TABLE 1
GRAIN SIZE ANALYSIS RESULTS
CLIFTY CREEK STATION
MADISON, INDIANA

CCR Unit	Boring No.	Sample Depth (feet)	70% Retention Size (mm)	Filter Pack Size (mm)	Screen Mesh (inches)	Unified Soil Classification Symbol & Description	
Type I Residual Waste Landfill and Landfill Runoff Collection Pond	Downgradient	24.0 - 34.0	0.05	0.40	0.01	SM	Silty Sand
Type I Residual Waste Landfill and Landfill Runoff Collection Pond - Background	BKG-2	29.0 - 35.0	0.0085	0.40	0.01	ML	Silt with Sand
Type I Residual Waste Landfill and Landfill Runoff Collection Pond - Background	BKG-3	33.0 - 43.0	0.015	0.40	0.01	ML	Silt
West Boiler Slag Pond	WAP-2	51.0 - 61.0	0.017	0.40	0.01	CL-ML	Sandy silty Clay

TABLE 2
GROUNDWATER MONITORING NETWORK
TYPE I RESIDUAL WASTE LANDFILL AND LANDFILL RUNOFF COLLECTION POND
CLIFTY CREEK STATION
MADISON, INDIANA

Monitoring Well ID	Designation	Date of Installation	Coordinates		Ground Elevation (ft)²	Top of Casing Elevation (ft)²	Top of Screen Elevation (ft)	Base of Screen Elevation (ft)	Total Depth From Top of Casing (ft)
			Northing	Easting					
CF-15-04	Background	12/3/2015	451482.81	569307.19	465.55	468.03	439.55	429.55	38.48
CF-15-05	Background/Intermediate	12/1/2015	447491.91	565533.64	439.85	442.58	422.85	412.85	29.73
CF-15-06	Background	11/30/2015	447026.92	565190.31	437.49	440.40	431.49	421.49	18.91
CF-15-07	Downgradient	11/23/2015	443135.08	562259.25	438.61	441.11	432.61	422.61	18.50
CF-15-08	Downgradient	11/19/2015	443219.57	562537.29	460.33	462.79	430.33	420.33	42.46
CF-15-09	Downgradient	11/25/2015	443445.96	562871.69	456.73	459.45	447.73	442.73	16.72
WBSP-15-01	Background	11/30/2015	449072.27	566322.12	466.93	469.36	458.93	448.93	20.43
WBSP-15-02	Background	11/11/2015	449803.91	566987.30	473.83	476.76	457.83	452.83	23.93

Notes:
1. The Well locations are referenced to the North American Datum (NAD83), east zone coordinate system.
2. Elevations are referenced to the North American Vertical Datum (NAVD) 1988

TABLE 3
GROUNDWATER MONITORING NETWORK
WEST BOILER SLAG POND
CLIFTY CREEK STATION
MADISON, INDIANA

Monitoring Well ID	Designation	Date of Installation	Coordinates		Ground Elevation (ft)[2]	Top of Casing Elevation (ft)[2]	Top of Screen Elevation (ft)	Base of Screen Elevation (ft)	Total Depth From Top of Casing (ft)
			Northing	Easting					
WBSP-15-01	Upgradient	11/30/2015	449072.27	566322.12	466.93	469.36	458.93	448.93	20.43
WBSP-15-02	Upgradient	11/11/2015	449803.91	566987.30	473.83	476.76	457.83	452.83	23.93
WBSP-15-03	Upgradient	12/4/2015	451181.98	568093.60	484.91	488.03	476.91	471.91	16.12
WBSP-15-04	Downgradient	11/12/2015	450610.07	568637.65	471.17	473.71	416.17	406.17	67.54
WBSP-15-05	Downgradient	11/17/2015	450051.40	568495.72	471.90	474.42	410.90	400.90	73.52
WBSP-15-06	Downgradient	11/19/2015	449470.57	568402.50	471.28	473.51	395.78	385.78	87.73
WBSP-15-07	Downgradient	11/23/2015	448947.93	567946.39	468.82	471.31	426.82	416.82	54.49
WBSP-15-08	Downgradient	11/25/2015	448625.46	567343.24	468.56	471.06	415.76	405.76	65.30
WBSP-15-09	Downgradient	1/6/2016	448359.31	566711.13	471.21	470.69	421.21	410.21	59.48
WBSP-15-10	Downgradient	1/5/2016	448125.51	566225.21	471.21	470.69	425.21	435.21	55.48

Notes:
1. The Well locations are referenced to the North American Datum (NAD83), east zone coordinate system.
2. Elevations are referenced to the North American Vertical Datum (NAVD) 1988

TABLE 4
SUMMARY OF AQUIFER TEST RESULTS
TYPE I RESIDUAL WASTE LANDFILL AND LANDFILL RUNOFF COLLECTION POND
CLIFTY CREEK STATION
MADISON, INDIANA
May 2016

Well	Test	Analytical Method	K (cm/sec)	Mean K (cm/sec)
CF-15-04 (Background)	Rising Head #1	Bouwer-Rice	1.82 E-2	1.51 E-2
		Hvorslev	2.21 E-2	
	Falling Head #1	Bouwer-Rice	9.26 E-3	
		Hvorslev	7.93 E-3	
	Rising Head #2	Bouwer-Rice	2.18 E-2	
		Hvorslev	2.65 E-2	
	Falling Head #2	Bouwer-Rice	5.95 E-3	
		Hvorslev	8.68 E-3	
CF-15-08 (Downgradient)	Rising Head #1	Bouwer-Rice	2.52 E-3	2.44 E-3
		Hvorslev	3.04 E-3	
	Falling Head #1	Bouwer-Rice	2.24 E-3	
		Hvorslev	2.70 E-3	
	Rising Head #2	Bouwer-Rice	1.90 E-3	
		Hvorslev	2.29 E-3	
	Falling Head #2	Bouwer-Rice	2.18 E-3	
		Hvorslev	2.62 E-3	

TABLE 5
SUMMARY OF AQUIFER TEST RESULTS
WEST BOILER SLAG POND
CLIFTY CREEK STATION
MADISON, INDIANA
May 2016

Well	Test	Analytical Method	K (cm/sec)	Mean K (cm/sec)
WBSP-15-02	Rising Head #1	Bouwer-Rice	5.65 E-6	1.04 E-5
		Hvorslev	7.41 E-6	
	Falling Head #1	Bouwer-Rice	1.23 E-5	
		Hvorslev	1.63 E-5	
WBSP-15-06	Rising Head #1	Bouwer-Rice	1.61 E-2	2.83 E-2
		Hvorslev	1.66 E-2	
	Falling Head #1	Bouwer-Rice	2.27 E-2	
		Hvorslev	2.27 E-2	
	Rising Head #2	Bouwer-Rice	3.63 E-2	
		Hvorslev	3.91 E-2	
	Falling Head #2	Bouwer-Rice	3.52 E-2	
		Hvorslev	3.78 E-2	
WBSP-15-07	Rising Head #1	Bouwer-Rice	9.24 E-6	1.02 E-5
		Hvorslev	1.06 E-5	
	Falling Head #1	Bouwer-Rice	9.66 E-6	
		Hvorslev	1.11 E-5	
			Mean K (cm/sec)	**9.44 E-3**

FIGURES

LEGEND:

△ SOIL BORING LOCATION

1200' 0' 1200' 2400'

SCALE: 1"= 1200'

DRAWN BY	JM
DATE	
CHECKED BY	
JOB NO.	2015067-CLI
DWG. FILE	IKEC_Clifty MW Install_Site Loc b01.dwg
DRAWING SCALE	AS SHOWN

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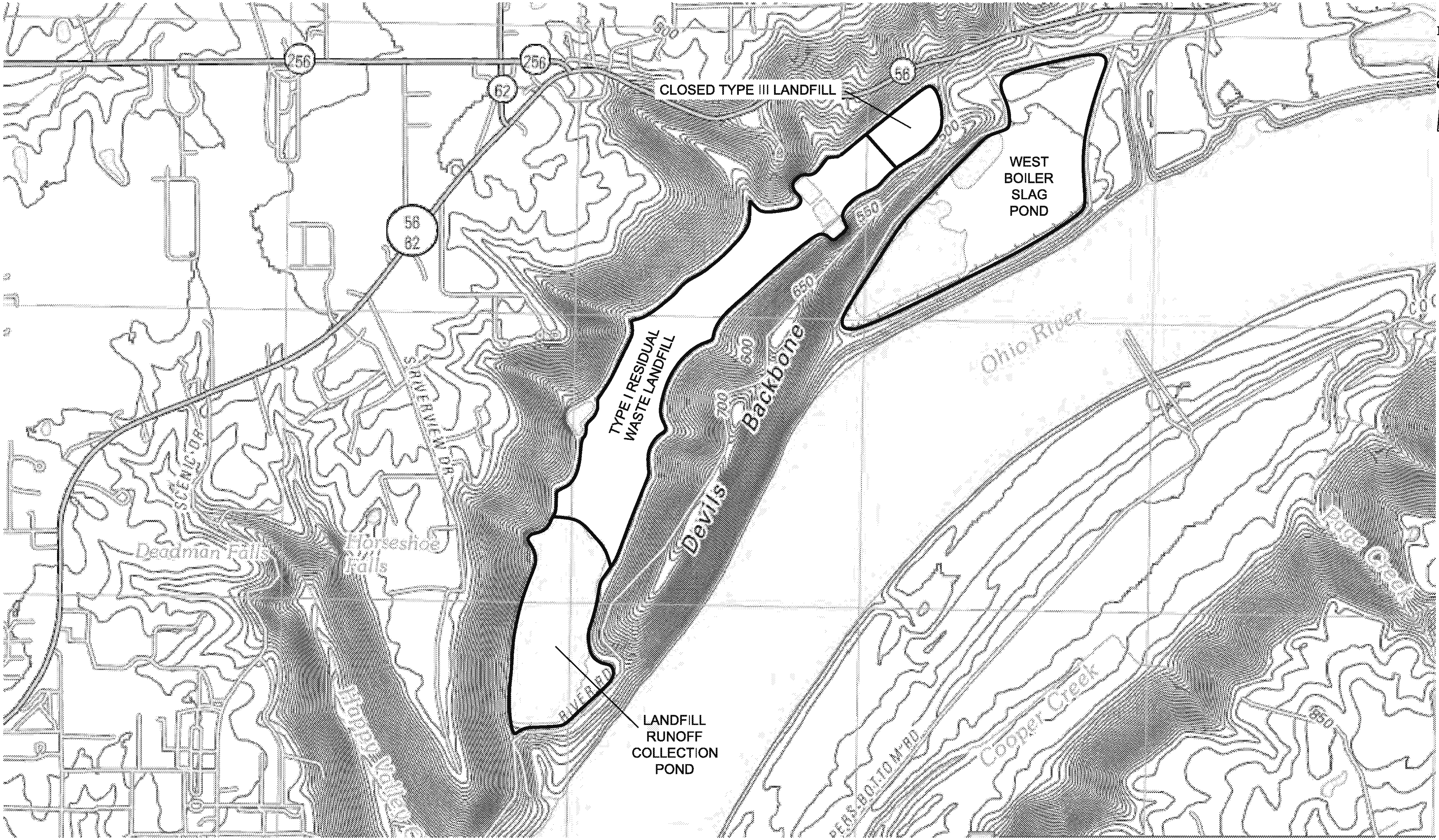
INDIANA–KENTUCKY ELECTRIC CORPORATION

CLIFTY CREEK STATION
MADISON, INDIANA
SITE LOCATION MAP AND SOIL BORING LOCATIONS

DRAWING NAME: FIGURE 1

REV. 0

Plot: 10/02/2018 14:17 _PROGRAMS–IKEC\Clifty Creek–CCR Program\CAD\Clifty CCR MW Install\IKEC_Clifty MW Install_Site Loc b01.dwg



SOURCE: USGS MADISON WEST 7.5 MINUTE TOPOGRAHIC QUADRANGLE, 2010.

DRAWN BY	JM
DATE	
CHECKED BY	
JOB NO.	2015067–CLIF
DWG FILE	IKEC_Clifty MW Install_USGS TOPO b05.dwg
DRAWING SCALE	NOT TO SCALE

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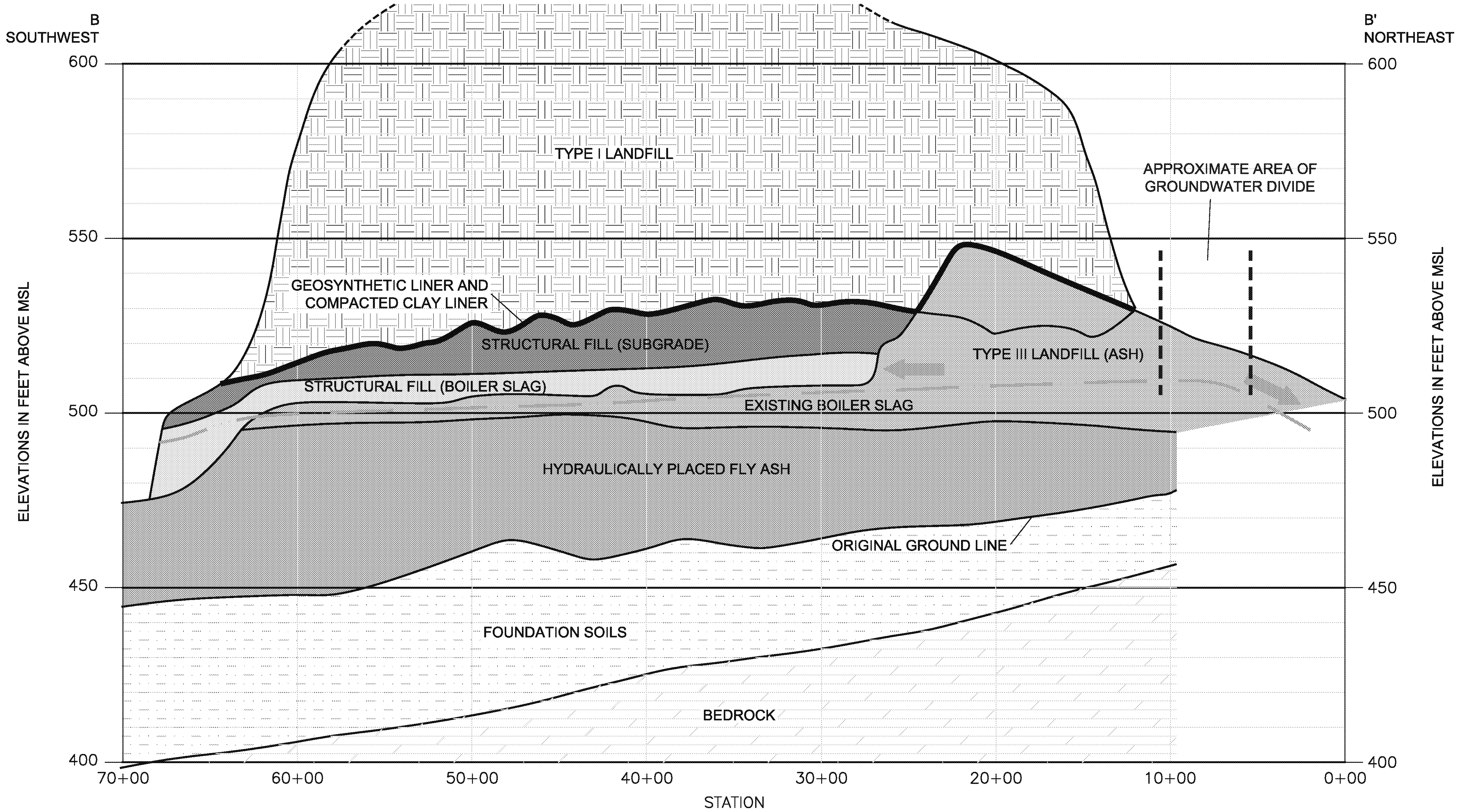
INDIANA–KENTUCKY ELECTRIC CORPORATION

CLIFTY CREEK STATION
MADISON, INDIANA
TOPOGRAPHIC MAP

DRAWING NAME: FIGURE 2

REV. 0

Plot: 09/28/2018 15:46 _PROGRAMS-IKEC\Clifty Creek-CCR Program\CAD\Clifty CCR MW Install\IKEC_Clifty MW Install_USGS TOPO b05.dwg



APPROXIMATE PHREATIC SURFACE

GROUNDWATER FLOW DIRECTION

DRAWN BY	JM
DATE	
CHECKED BY	
JOB NO.	2018070-2-CLI
DWG FILE	IKEC_Clifty MW Install_Cross Sec b08.dwg
DRAWING SCALE	NOT TO SCALE

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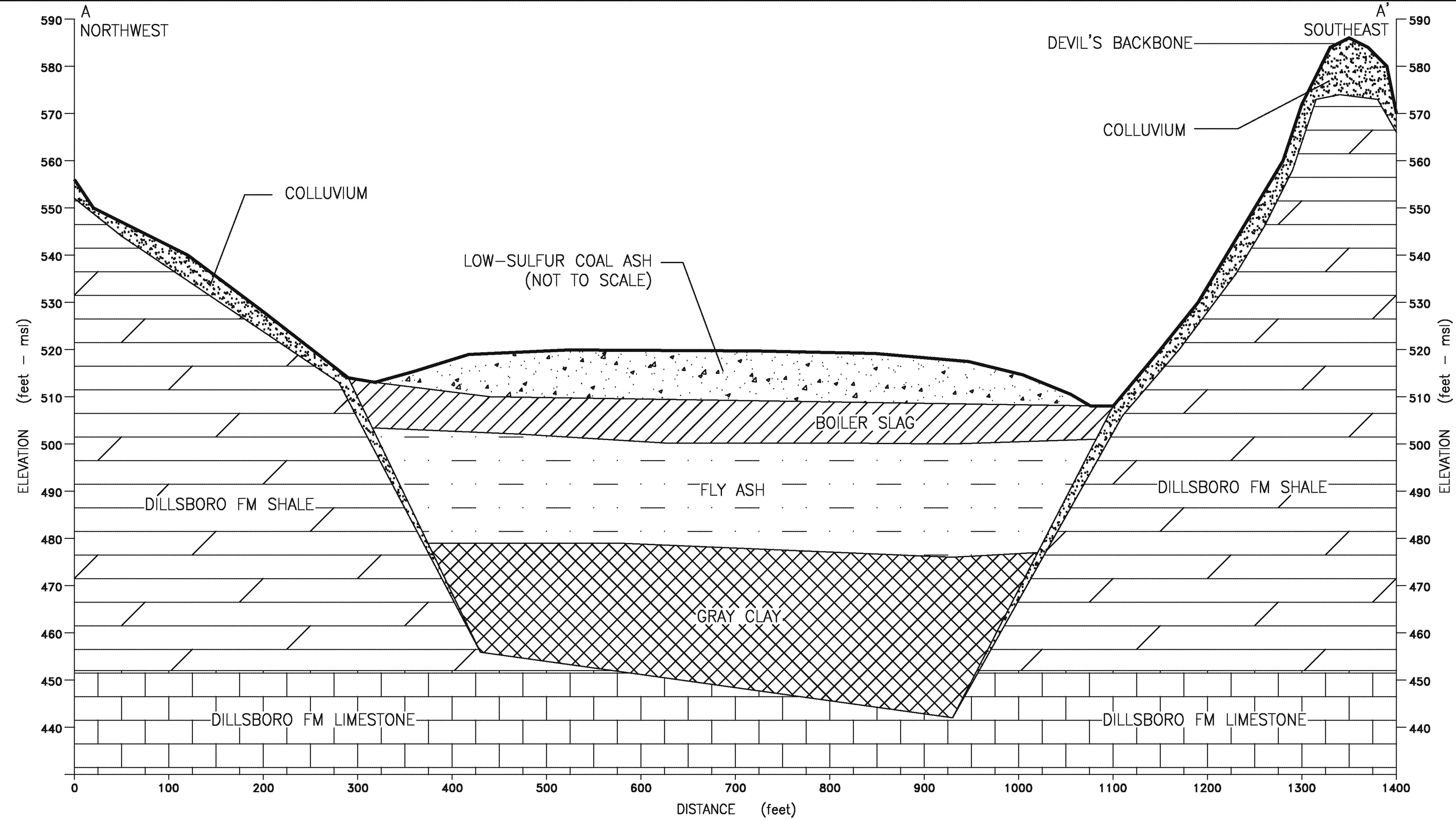
INDIANA–KENTUCKY ELECTRIC CORPORATION

CLIFTY CREEK STATION
MADISON, INDIANA
TYPE I RESIDUAL WASTE LANDFILL
GENERALIZED GEOLOGIC CROSS–SECTION
B–B' (SOUTHWEST–NORTHEAST)

DRAWING NAME: FIGURE 3

REV. 0

Plot: 10/08/2018 14:53 _PROGRAM–IKEC\Clifty Creek–CCR Program\CAD\Clifty CCR MW Install\IKEC_Clifty MW Install_Cross Sec b08.dwg



NOTE:
CROSS-SECTION LOCATION SHOWN ON FIGURE 1.

SOURCE: HYDROGEOLOGIC STUDY REPORT, AGES, APRIL 2007.

100' 0' 100' 200'
HORIZONTAL SCALE: 1"=100'
VERTICAL SCALE 1" = 20'

DRAWN BY	JM
DATE	
CHECKED BY	
JOB NO.	2015067-CLIF
DWG FILE	IKEC_Clifty MW Install_Gen XSection b06.dwg
DRAWING SCALE	AS SHOWN

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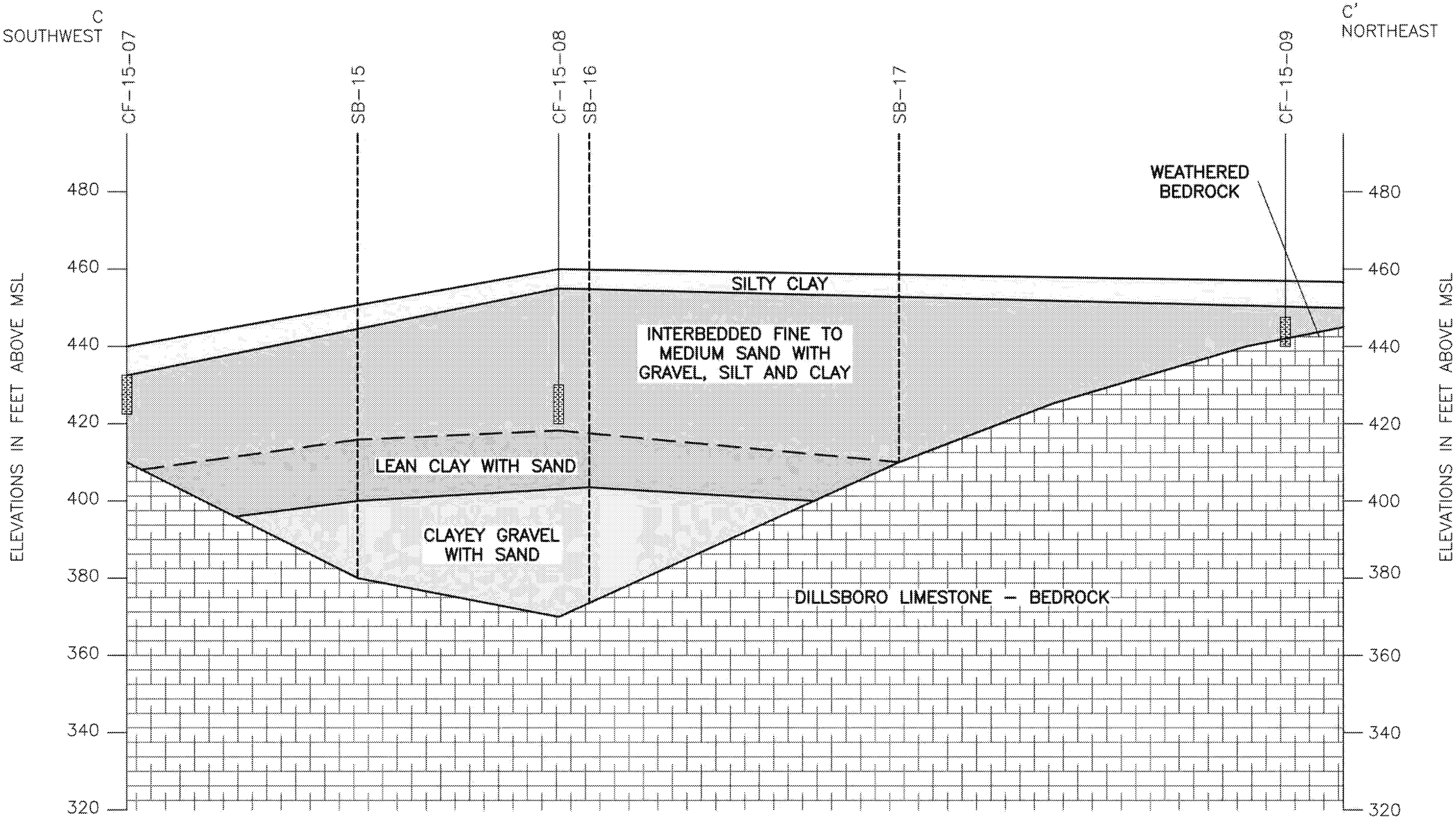
INDIANA-KENTUCKY ELECTRIC CORPORATION
CLIFTY CREEK STATION
MADISON, INDIANA
TYPE I RESIDUAL WASTE LANDFILL AND LANDFILL RUNOFF COLLECTION POND
GENERALIZED GEOLOGIC CROSS-SECTION
A-A' (NORTHWEST-SOUTHEAST)

DRAWING NAME: FIGURE 4
REV. 0

Plot: 10/05/2018 13:12 _PROGRAMS-IKEC\Clifty Creek-CCR Program\CAD\Clifty CCR MW Install\IKEC_Clifty MW Install_Gen XSection b06.dwg



NOTES:
1) CROSS-SECTION LOCATION SHOWN ON FIGURE 1.
2) SOIL BORINGS SB-15, SB-16 AND SB-17 WERE DRILLED FOR THE 2006 LITIGATION REPORT TO DETERMINE DEPTH TO BEDROCK ONLY - DETAILED GEOLOGIC LOGS WERE NOT MAINTAINED (AGES 2006).
3) THE LEAN CLAY WITH SAND LAYER AND THE CLAYEY GRAVEL WITH SAND LAYER BASED ON DATA FROM THE STANTEC LRCP STABILITY ASSESSMENT REPORT (STANTEC 2016).

DRAWN BY	JM
DATE	
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JOB NO.	2018070-2-CLIF
DWG FILE	IKEC_Clifty MW Install_X-Sec C-C' b09.dwg
DRAWING SCALE	NOT TO SCALE

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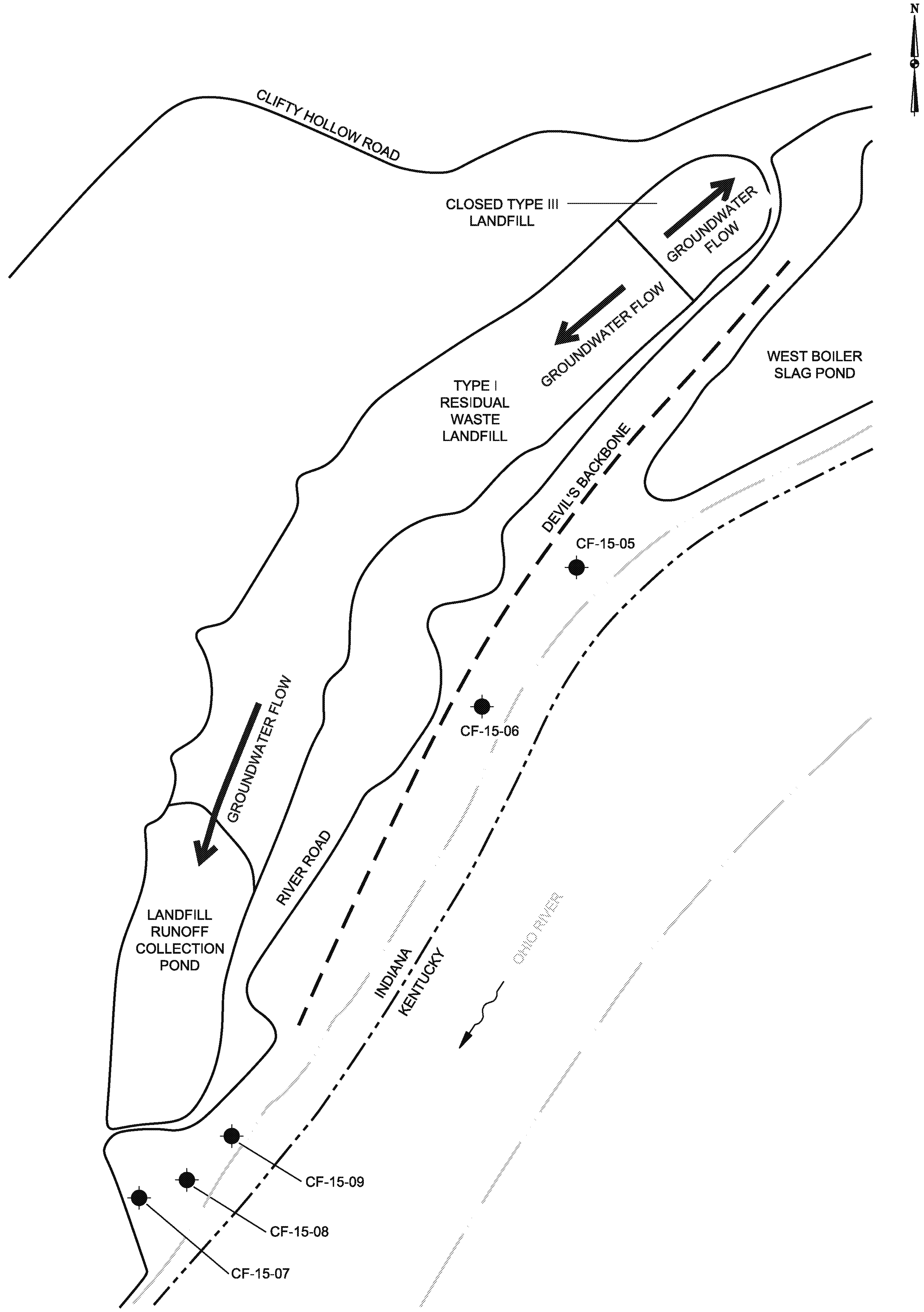
INDIANA-KENTUCKY ELECTRIC CORPORATION
CLIFTY CREEK STATION
MADISON, INDIANA
TYPE I RESIDUAL WASTE LANDFILL AND LANDFILL RUNOFF COLLECTION POND
GENERALIZED GEOLOGIC CROSS-SECTION C-C'

DRAWING NAME: FIGURE 5
REV. 0

Plot: 10/08/2018 14:56 _PROGRAM-IKEC\Clifty Creek-CCR Program\CAD\Clifty CCR MW Install\IKEC_Clifty MW Install_X-Sec C-C' b09.dwg



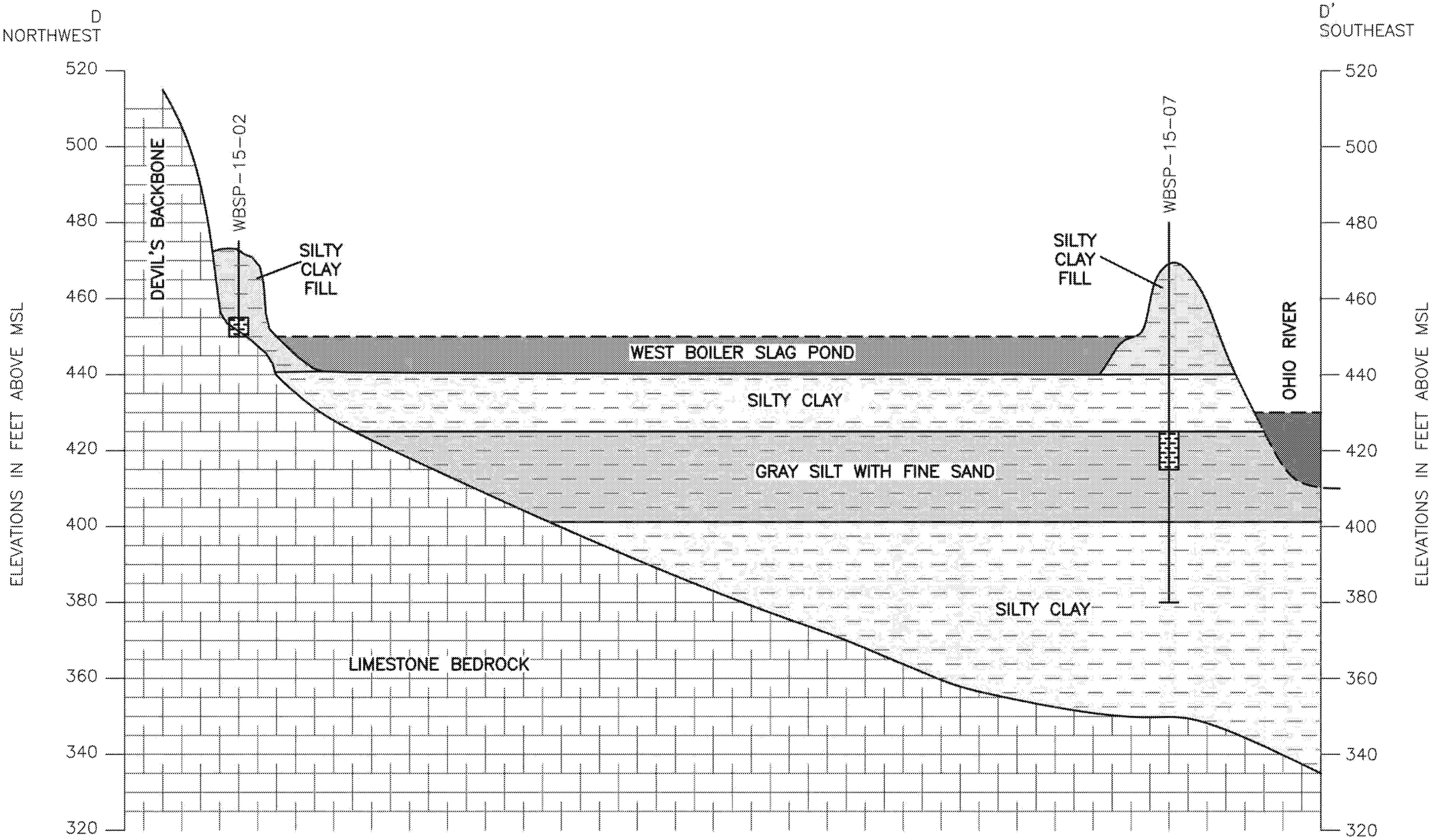
LEGEND:

MONITORING WELL LOCATION

NOTE:
SEE FIGURE 7 FOR LOCATION OF BACKGROUND WELL CF-15-04.

DRAWN BY	JM	AGES Applied Geology And Environmental Science, Inc. 2402 Hookstown Grade Road, Suite 200 Clinton, PA 15026 412.264.6453	INDIANA-KENTUCKY ELECTRIC CORPORATION	
DATE			CLIFTY CREEK STATION MADISON, INDIANA TYPE I RESIDUAL WASTE LANDFILL AND LANDFILL RUNOFF COLLECTION POND MONITORING WELL LOCATIONS AND GENERALIZED GROUNDWATER FLOW	
CHECKED BY				
JOB NO.	2015067-CLIF			
DWG FILE	IKEC_Clifty MWs_LANDFILL b01.dwg		DRAWING NAME FIGURE 6	REV. 0
DRAWING SCALE	NOT TO SCALE			

Plot: 10/02/2018 14:42 _PROGRAMS-IKEC\Clifty Creek-CCR Program\CAD\Clifty CCR MW Install\IKEC_Clifty MWs_LANDFILL b01.dwg



NOTE:
CROSS-SECTION LOCATION SHOWN ON FIGURE 1.

DRAWN BY	JM
DATE	
CHECKED BY	
JOB NO.	2015067-CLIF
DWG FILE	IKEC_Clifty MW Install_Slag Pond X-Sec b07.dwg
DRAWING SCALE	NOT TO SCALE

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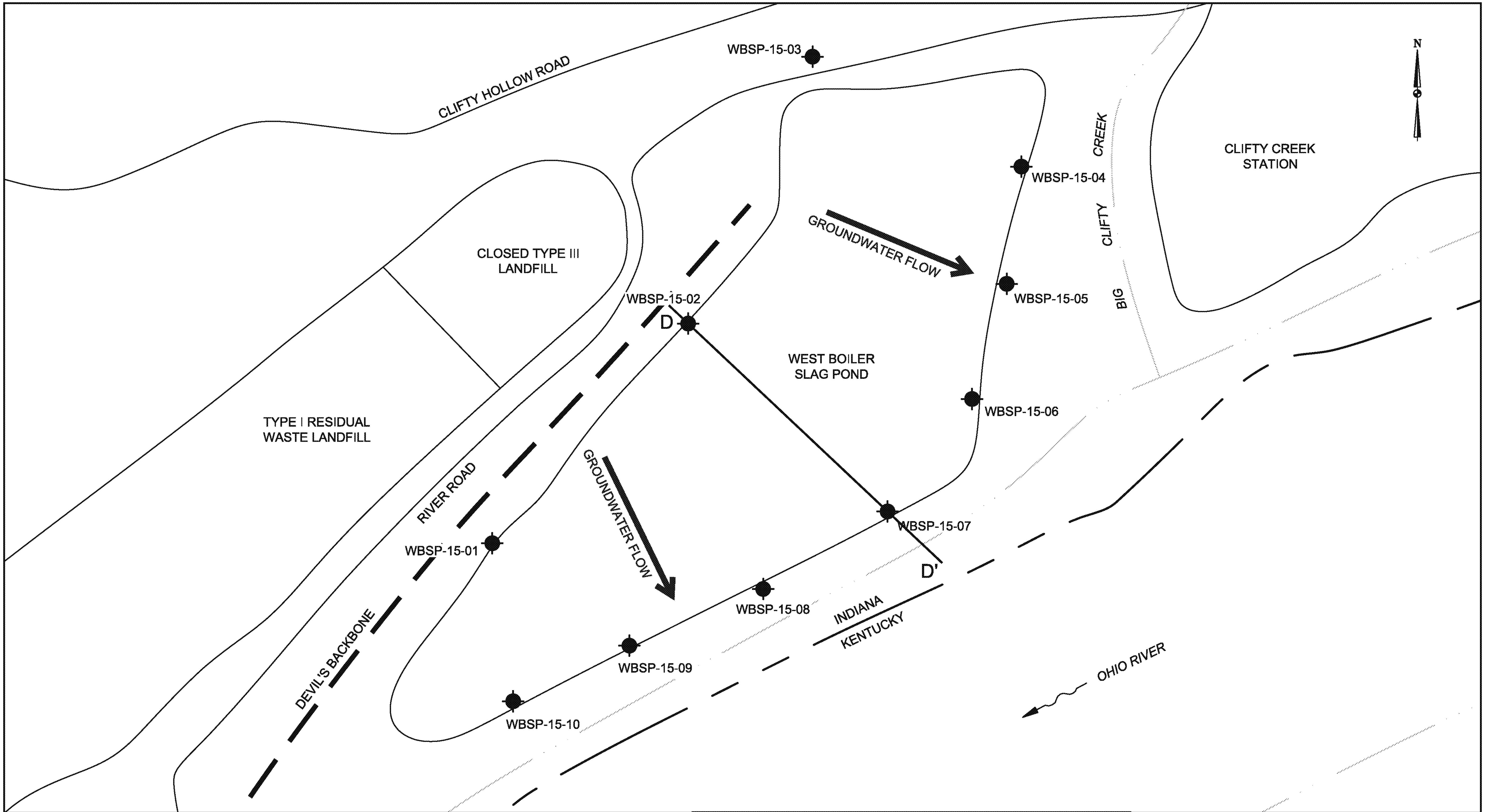
INDIANA-KENTUCKY ELECTRIC CORPORATION

CLIFTY CREEK STATION
MADISON, INDIANA
WEST BOILER SLAG POND
GENERALIZED GEOLOGIC CROSS-SECTION D-D'

DRAWING NAME: FIGURE 7
REV. 0

Plot: 10/08/2018 15:17 _PROGRAM-IKEC\Clifty Creek-CCR Program\CAD\Clifty CCR MW Install\IKEC_Clifty MW Install_Slag Pond X-Sec b07.cwg



LEGEND:

MONITORING WELL LOCATION

400' 0' 400' 800'

SCALE: 1"= 400'

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DATE	
CHECKED BY	
JOB NO.	2015067-CLI
DWG FILE	IKEC_Clifty MW Install_MWs_b02-b03-b04.dwg
DRAWING SCALE	AS SHOWN

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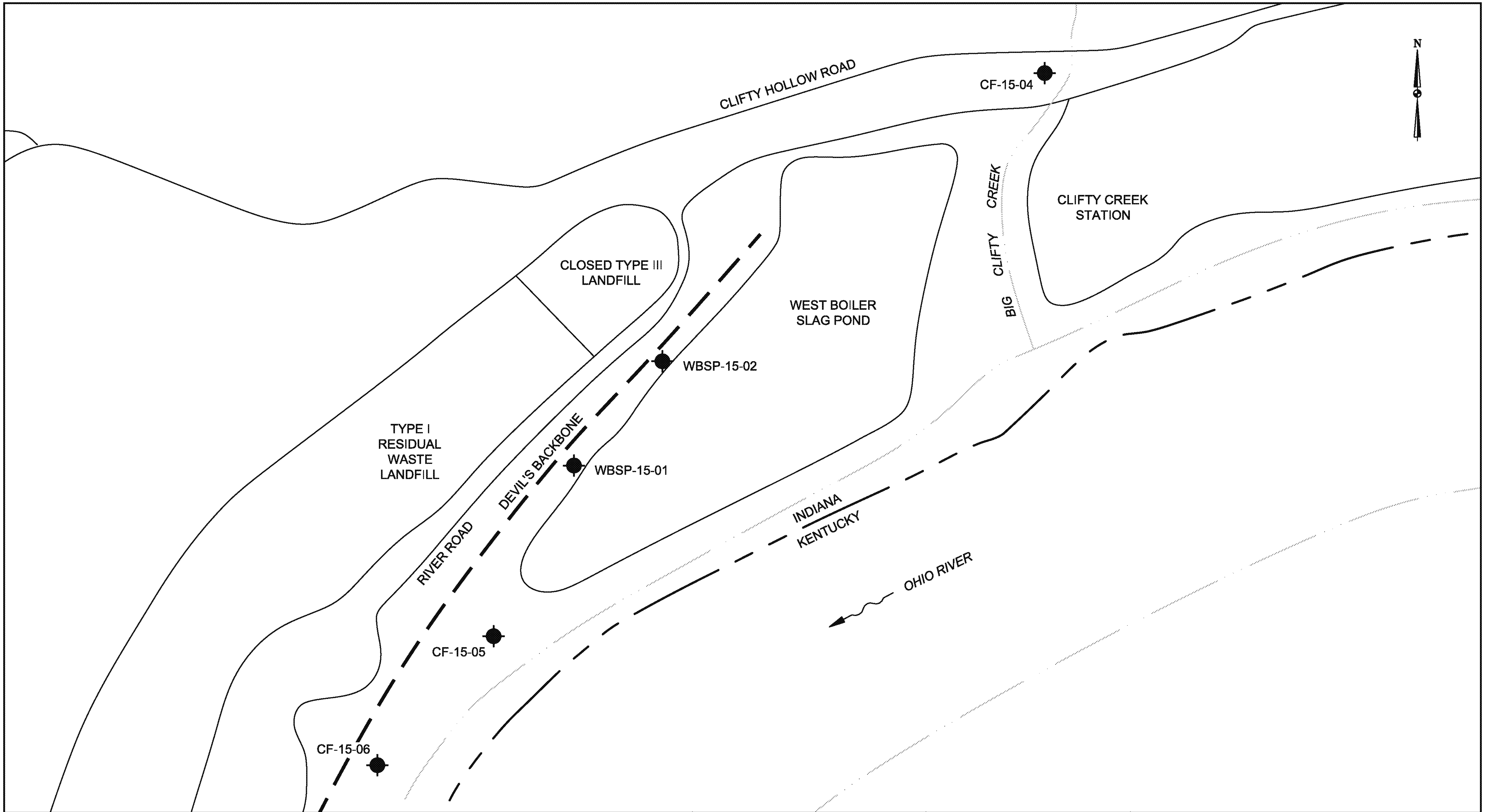
INDIANA-KENTUCKY ELECTRIC CORPORATION

CLIFTY CREEK STATION
MADISON, INDIANA
WEST BOILER SLAG POND
MONITORING WELL LOCATIONS AND
GENERALIZED GROUNDWATER FLOW

DRAWING NAME: FIGURE 8

REV. 0

Plot: 10/02/2018 14:46 _PROGRAMS-IKEC\Clifty Creek-CCR Program\CAD\Clifty CCR MW Install\IKEC_Clifty MW Install_MWs_b02-b03-b04.dwg\b04



LEGEND:
● MONITORING WELL LOCATION

600' 0' 600' 1200'
SCALE: 1"= 600'

DRAWN BY	JM
DATE	
CHECKED BY	
JOB NO.	2015067-CLI
DWG FILE	IKEC_Clifty MW Install_MWs_b02-b03-b04.dwg
DRAWING SCALE	AS SHOWN

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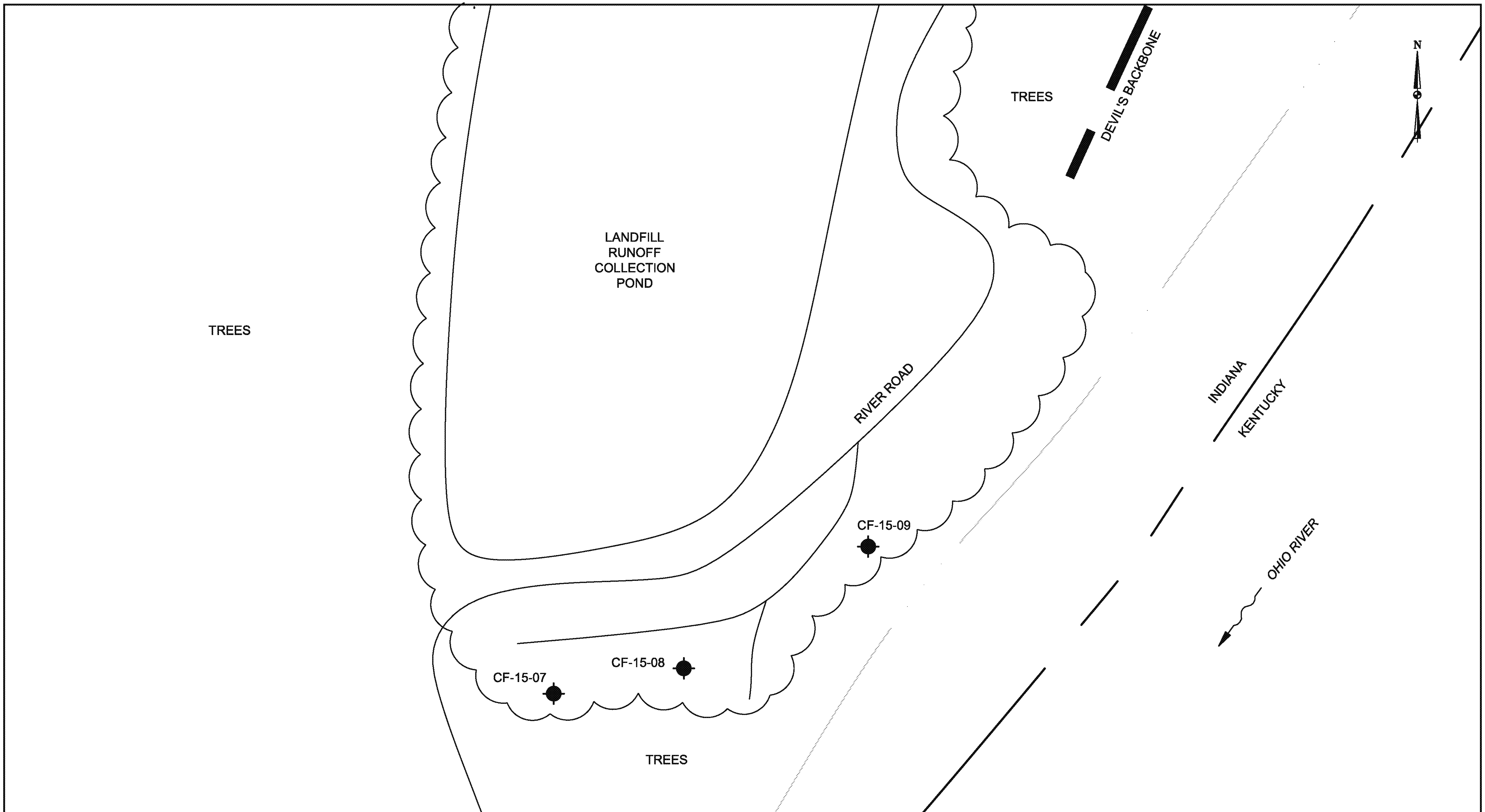
CLIFTY CREEK STATION
MADISON, INDIANA
TYPE I RESIDUAL WASTE LANDFILL AND
LANDFILL RUNOFF COLLECTION POND
BACKGROUND MONITORING WELL LOCATIONS

DRAWING NAME: FIGURE 9
REV. 0

Plot: 10/02/2018 14:50 _PROGRAMS-IKEC\Clifty Creek-CCR Program\CAD\Clifty CCR MW Install\IKEC_Clifty_MWs_b02-b03-b04.dwg\b02



LEGEND:

MONITORING WELL LOCATION

200' 0' 200' 400'

SCALE: 1"= 200'

DRAWN BY	JM
DATE	
CHECKED BY	
JOB NO.	2015067-CLI
DWG. FILE	IKEC_Clifty MW Install_MWs_b02-b03-b04.dwg
DRAWING SCALE	AS SHOWN

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INDIANA–KENTUCKY ELECTRIC CORPORATION

CLIFTY CREEK STATION
MADISON, INDIANA
TYPE I RESIDUAL WASTE LANDFILL AND
LANDFILL RUNOFF COLLECTION POND
MONITORING WELL LOCATIONS

DRAWING NAME: FIGURE 10

REV. 0

Plot: 10/02/2018 14:52 _PROGRAMS-IKEC\Clifty Creek-CCR Program\CAD\Clifty CCR MW Install\IKEC_Clifty MW Install_MWs_b02-b03-b04.dwg\b03

APPENDIX A

GRAIN SIZE ANALYSIS RESULTS

Stantec

Summary of Soil Tests

Project Name: Clifty Creek IKEC CCR Rule Eng
Project Number: 175534018
Source: WAP-2-51-61, 51.0'-61.0'
Lab ID: 2

Sample Type: SPT
Date Received: 7-21-15
Date Reported: 7-27-15

Test Results

Natural Moisture Content

Test Not Performed
Moisture Content (%): N/A

Particle Size Analysis

Preparation Method: ASTM D 421
Gradation Method: ASTM D 422
Hydrometer Method: ASTM D 422

Particle Size Sieve Size	Particle Size (mm)	% Passing
	N/A	
	N/A	
	N/A	
	N/A	
	N/A	
3/8"	9.5	100.0
No. 4	4.75	99.2
No. 10	2	98.0
No. 40	0.425	96.8
No. 200	0.075	69.6
	0.02	34.7
	0.005	17.0
	0.002	11.2
estimated	0.001	7.0

Plus 3 in. material, not included: 0 (%)

Range	ASTM (%)	AASHTO (%)
Gravel	0.8	2.0
Coarse Sand	1.2	1.2
Medium Sand	1.2	---
Fine Sand	27.2	27.2
Silt	52.6	58.4
Clay	17.0	11.2

Atterberg Limits

Test Method: ASTM D 4318 Method A
Prepared: Dry
Liquid Limit: 23
Plastic Limit: 19
Plasticity Index: 4
Activity Index: 0.36

Moisture-Density Relationship

Test Not Performed
Maximum Dry Density (lb/ft^3): N/A
Maximum Dry Density (kg/m^3): N/A
Optimum Moisture Content (%): N/A
Over Size Correction %: N/A

California Bearing Ratio

Test Not Performed
Bearing Ratio (%): N/A
Compacted Dry Density (lb/ft^3): N/A
Compacted Moisture Content (%): N/A

Specific Gravity

Estimated
Particle Size: No. 10
Specific Gravity at 20° Celsius: 2.65

Classification

Unified Group Symbol: CL-ML
Group Name: Sandy silty clay
AASHTO Classification: A-4 (1)

Comments:

Reviewed By RJ

Stantec Consulting Services Inc.
Lexington, Kentucky

Stantec

Particle-Size Analysis of Soils
ASTM D 422

Project Name	Clifty Creek IKEC CCR Rule Eng	Project Number	175534018
Source	WAP-2-51-61, 51.0'-61.0'	Lab ID	2

Sieve analysis for the Portion Coarser than the No. 10 Sieve

Test Method: ASTM D 422
Prepared using: ASTM D 421

Particle Shape: Angular
Particle Hardness: Hard and Durable

Tested By: TA
Test Date: 07-22-2015
Date Received: 07-21-2015

Maximum Particle size: 3/8" Sieve

Sieve Size	% Passing
3/8"	100.0
No. 4	99.2
No. 10	98.0

Analysis for the portion Finer than the No. 10 Sieve

Analysis Based on -3 inch fraction only

Specific Gravity: 2.65

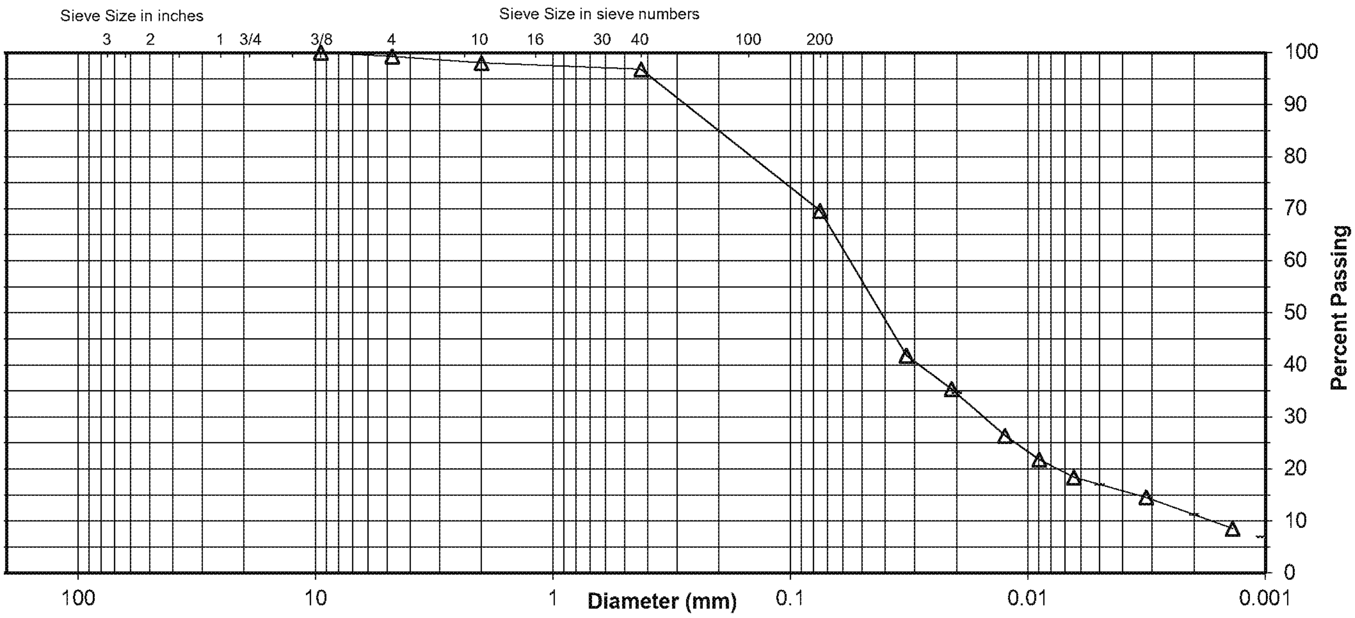
Dispersed using Apparatus A - Mechanical, for 1 minute

No. 40	96.8
No. 200	69.6
0.02 mm	34.7
0.005 mm	17.0
0.002 mm	11.2
0.001 mm	7.0

Particle Size Distribution

ASTM	Coarse Gravel	Fine Gravel	C. Sand	Medium Sand	Fine Sand	Silt	Clay
	0.0	0.8	1.2	1.2	27.2	52.6	17.0

AASHTO	Gravel	Coarse Sand	Fine Sand	Silt	Clay
	2.0	1.2	27.2	58.4	11.2



Comments ______

Reviewed By RJ

File: frm_175534018_sum_2.xlsm
Preparation Date: 1998
Revision Date: 1-2008

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Lexington, Kentucky

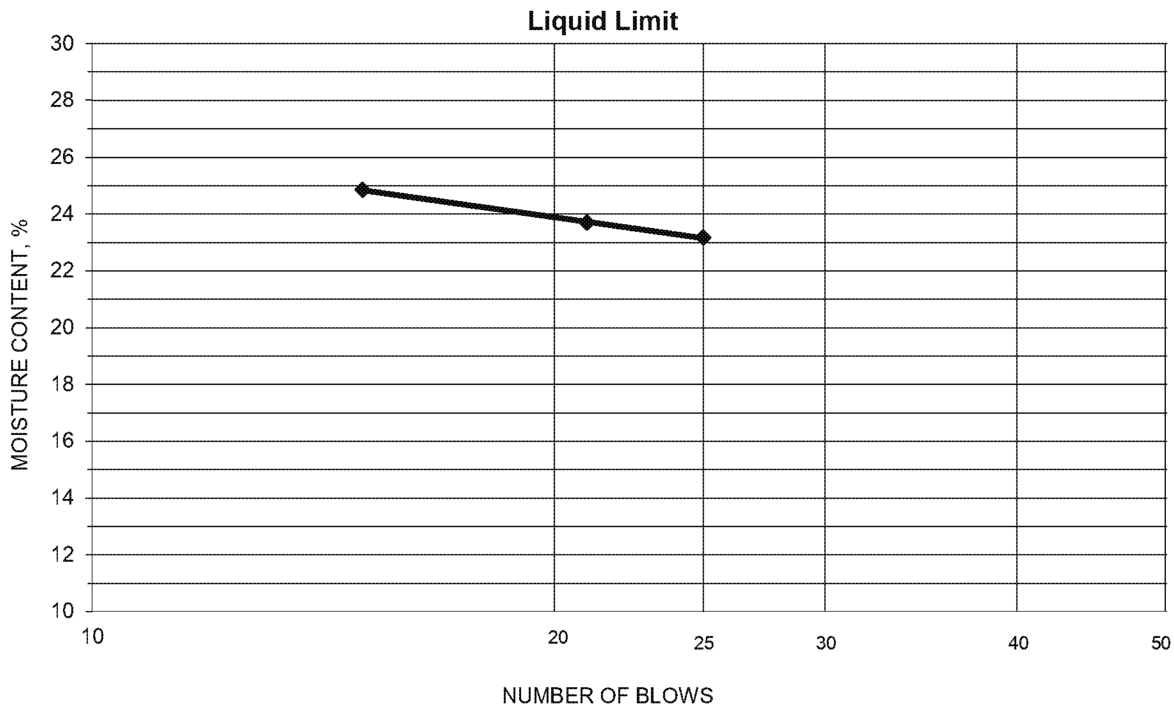
Laboratory Document
Prepared By: MW
Approved BY: TLK

Stantec

ATTERBERG LIMITS

Project	Clifty Creek IKEC CCR Rule Eng			Project No.	175534018
Source	WAP-2-51-61, 51.0'-61.0'			Lab ID	2
				% + No. 40	3
Tested By	KG	Test Method	ASTM D 4318 Method A	Date Received	07-21-2015
Test Date	07-31-2015	Prepared	Dry		

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Number of Blows	Water Content (%)	Liquid Limit
23.91	21.55	11.59	21	23.7	23
24.82	22.29	11.37	25	23.2	
27.00	23.79	10.87	15	24.8	



PLASTIC LIMIT AND PLASTICITY INDEX

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Water Content (%)	Plastic Limit	Plasticity Index
22.36	20.83	12.71	18.8	19	4
20.94	19.66	12.73	18.5		

Remarks:

Reviewed By RJ

Stantec

Summary of Soil Tests

Project Name	Clifty Creek IKEC CCR Rule Eng	Project Number	175534018
Source	SW-24-34, 24.0'-34.0'	Lab ID	1
Sample Type	SPT	Date Received	7-21-15
		Date Reported	7-27-15

Test Results

Natural Moisture Content

Test Not Performed

Moisture Content (%): N/A

Particle Size Analysis

Preparation Method: ASTM D 421

Gradation Method: ASTM D 422

Hydrometer Method: ASTM D 422

Particle Size		%
Sieve Size	(mm)	Passing
	N/A	
	N/A	
	N/A	
	N/A	
3/4"	19	100.0
3/8"	9.5	99.0
No. 4	4.75	96.5
No. 10	2	93.0
No. 40	0.425	90.7
No. 200	0.075	37.8
	0.02	13.6
	0.005	5.8
	0.002	3.5
estimated	0.001	2.0

Plus 3 in. material, not included: 0 (%)

Range	ASTM (%)	AASHTO (%)
Gravel	3.5	7.0
Coarse Sand	3.5	2.3
Medium Sand	2.3	---
Fine Sand	52.9	52.9
Silt	32.0	34.3
Clay	5.8	3.5

Atterberg Limits

Test Method: ASTM D 4318 Method A

Prepared: Dry

Liquid Limit: NP

Plastic Limit: NP

Plasticity Index: NP

Activity Index: N/A

Moisture-Density Relationship

Test Not Performed

Maximum Dry Density (lb/ft^3): N/A

Maximum Dry Density (kg/m^3): N/A

Optimum Moisture Content (%): N/A

Over Size Correction %: N/A

California Bearing Ratio

Test Not Performed

Bearing Ratio (%): N/A

Compacted Dry Density (lb/ft^3): N/A

Compacted Moisture Content (%): N/A

Specific Gravity

Estimated

Particle Size: No. 10

Specific Gravity at 20° Celsius: 2.65

Classification

Unified Group Symbol: SM

Group Name: Silty sand

AASHTO Classification: A-4 (0)

Comments:

Reviewed By RJ

File: frm_175534018_sum_1.xlsm
Preparation Date: 1998
Revision Date: 1-2008

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Lexington, Kentucky

Laboratory Document
Prepared By: MW
Approved BY: TLK

Stantec

Particle-Size Analysis of Soils
ASTM D 422

Project Name	Clifty Creek IKEC CCR Rule Eng	Project Number	175534018
Source	SW-24-34, 24.0'-34.0'	Lab ID	1

Sieve analysis for the Portion Coarser than the No. 10 Sieve

Test Method: ASTM D 422
Prepared using: ASTM D 421

Particle Shape: Angular
Particle Hardness: Hard and Durable

Tested By: JS
Test Date: 07-22-2015
Date Received: 07-21-2015

Maximum Particle size: 3/4" Sieve

Sieve Size	% Passing
3/4"	100.0
3/8"	99.0
No. 4	96.5
No. 10	93.0

Analysis for the portion Finer than the No. 10 Sieve

Analysis Based on -3 inch fraction only

Specific Gravity: 2.65

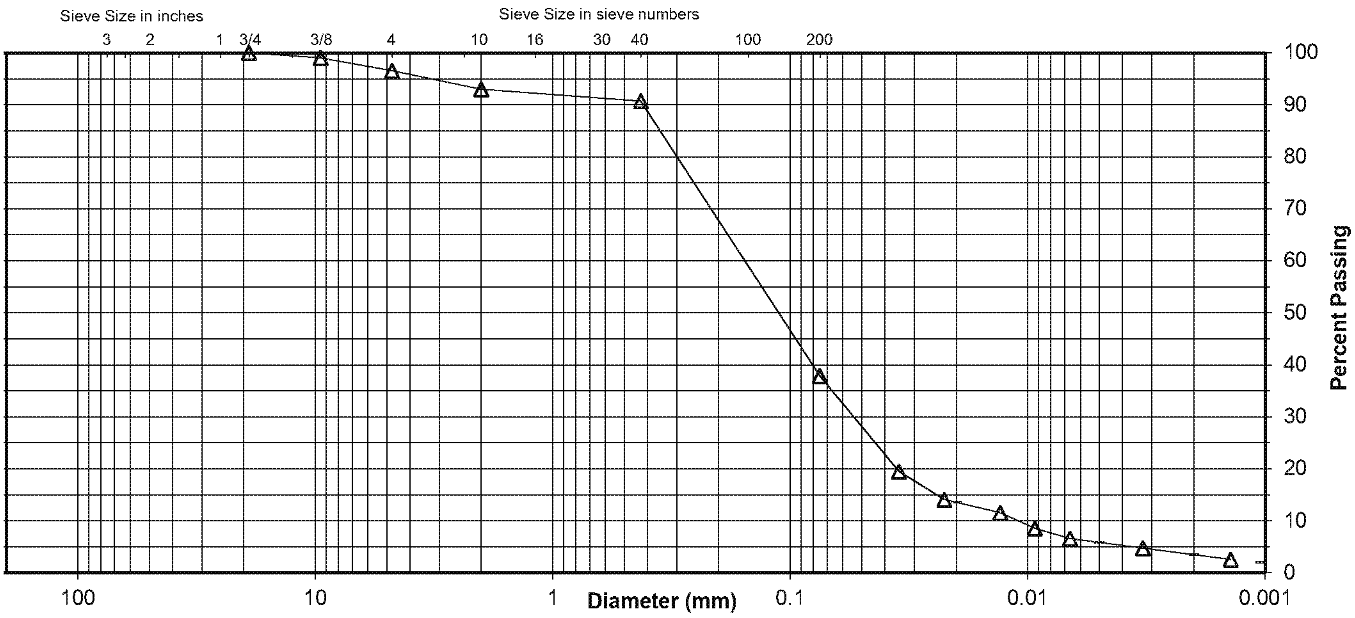
Dispersed using Apparatus A - Mechanical, for 1 minute

No. 40	90.7
No. 200	37.8
0.02 mm	13.6
0.005 mm	5.8
0.002 mm	3.5
0.001 mm	2.0

Particle Size Distribution

ASTM	Coarse Gravel	Fine Gravel	C. Sand	Medium Sand	Fine Sand	Silt	Clay
	0.0	3.5	3.5	2.3	52.9	32.0	5.8

AASHTO	Gravel	Coarse Sand	Fine Sand	Silt	Clay
	7.0	2.3	52.9	34.3	3.5



Comments ____________________

Reviewed By RJ

File: frm_175534018_sum_1.xlsm
Preparation Date: 1998
Revision Date: 1-2008

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Lexington, Kentucky

Laboratory Document
Prepared By: MW
Approved BY: TLK

Stantec

Summary of Soil Tests

Project Name	Clifty Creek IKEC CCR Rule Eng	Project Number	175534018
Source	BKG-3-33-43, 33.0'-43.0'	Lab ID	3
Sample Type	SPT	Date Received	7-21-15
		Date Reported	7-27-15

Test Results

Natural Moisture Content

Test Not Performed

Moisture Content (%): N/A

Particle Size Analysis

Preparation Method: ASTM D 421

Gradation Method: ASTM D 422

Hydrometer Method: ASTM D 422

Particle Size		%
Sieve Size	(mm)	Passing
	N/A	
	N/A	
	N/A	
	N/A	
	N/A	
3/8"	9.5	100.0
No. 4	4.75	99.8
No. 10	2	99.7
No. 40	0.425	99.6
No. 200	0.075	98.4
	0.02	42.5
	0.005	10.7
	0.002	6.3
estimated	0.001	3.0

Plus 3 in. material, not included: 0 (%)

Range	ASTM (%)	AASHTO (%)
Gravel	0.2	0.3
Coarse Sand	0.1	0.1
Medium Sand	0.1	---
Fine Sand	1.2	1.2
Silt	87.7	92.1
Clay	10.7	6.3

Atterberg Limits

Test Method: ASTM D 4318 Method A

Prepared: Dry

Liquid Limit: NP

Plastic Limit: NP

Plasticity Index: NP

Activity Index: N/A

Moisture-Density Relationship

Test Not Performed

Maximum Dry Density (lb/ft^3): N/A

Maximum Dry Density (kg/m^3): N/A

Optimum Moisture Content (%): N/A

Over Size Correction %: N/A

California Bearing Ratio

Test Not Performed

Bearing Ratio (%): N/A

Compacted Dry Density (lb/ft^3): N/A

Compacted Moisture Content (%): N/A

Specific Gravity

Estimated

Particle Size: No. 10

Specific Gravity at 20° Celsius: 2.65

Classification

Unified Group Symbol: ML

Group Name: Silt

AASHTO Classification: A-4 (0)

Comments:

Reviewed By RJ

Stantec

Particle-Size Analysis of Soils
ASTM D 422

Project Name	Clifty Creek IKEC CCR Rule Eng	Project Number	175534018
Source	BKG-3-33-43, 33.0'-43.0'	Lab ID	3

Sieve analysis for the Portion Coarser than the No. 10 Sieve

Test Method: ASTM D 422
Prepared using: ASTM D 421

Particle Shape: Angular
Particle Hardness: Hard and Durable

Tested By: TA
Test Date: 07-22-2015
Date Received: 07-21-2015

Maximum Particle size: 3/8" Sieve

Sieve Size	% Passing
3/8"	100.0
No. 4	99.8
No. 10	99.7

Analysis for the portion Finer than the No. 10 Sieve

Analysis Based on -3 inch fraction only

Specific Gravity: 2.65

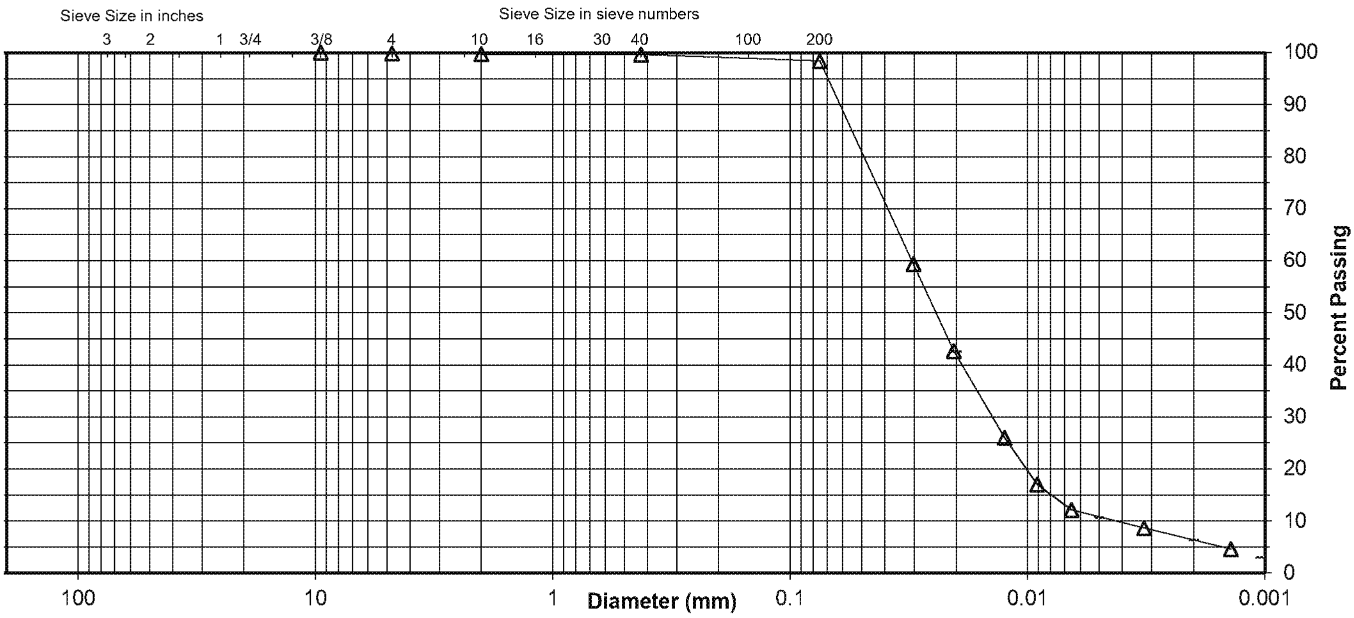
Dispersed using Apparatus A - Mechanical, for 1 minute

No. 40	99.6
No. 200	98.4
0.02 mm	42.5
0.005 mm	10.7
0.002 mm	6.3
0.001 mm	3.0

Particle Size Distribution

ASTM	Coarse Gravel	Fine Gravel	C. Sand	Medium Sand	Fine Sand	Silt	Clay
	0.0	0.2	0.1	0.1	1.2	87.7	10.7

AASHTO	Gravel	Coarse Sand	Fine Sand	Silt	Clay
	0.3	0.1	1.2	92.1	6.3



Comments ______

Reviewed By RJ

Stantec

Summary of Soil Tests

Project Name	Clifty Creek IKEC CCR Rule Eng	Project Number	175534018
Source	BKG-2-29-35, 29.0'-35.0'	Lab ID	4
Sample Type	SPT	Date Received	7-23-15
		Date Reported	7-31-15

Test Results

Natural Moisture Content

Test Not Performed

Moisture Content (%): N/A

Particle Size Analysis

Preparation Method: ASTM D 421
Gradation Method: ASTM D 422
Hydrometer Method: ASTM D 422

Particle Size Sieve Size	Particle Size (mm)	% Passing
	N/A	
	N/A	
	N/A	
	N/A	
3/4"	19	100.0
3/8"	9.5	98.6
No. 4	4.75	98.1
No. 10	2	96.8
No. 40	0.425	94.3
No. 200	0.075	79.8
	0.02	46.9
	0.005	23.4
	0.002	16.0
estimated	0.001	12.0

Plus 3 in. material, not included: 0 (%)

Range	ASTM (%)	AASHTO (%)
Gravel	1.9	3.2
Coarse Sand	1.3	2.5
Medium Sand	2.5	---
Fine Sand	14.5	14.5
Silt	56.4	63.8
Clay	23.4	16.0

Atterberg Limits

Test Method: ASTM D 4318 Method A
Prepared: Dry

Liquid Limit: NP
Plastic Limit: NP
Plasticity Index: NP
Activity Index: N/A

Moisture-Density Relationship

Test Not Performed

Maximum Dry Density (lb/ft^3): N/A
Maximum Dry Density (kg/m^3): N/A
Optimum Moisture Content (%): N/A
Over Size Correction %: N/A

California Bearing Ratio

Test Not Performed

Bearing Ratio (%): N/A
Compacted Dry Density (lb/ft^3): N/A
Compacted Moisture Content (%): N/A

Specific Gravity

Estimated

Particle Size: No. 10
Specific Gravity at 20° Celsius: 2.70

Classification

Unified Group Symbol: ML
Group Name: Silt with sand

AASHTO Classification: A-4 (0)

Comments:

Reviewed By RJ

Stantec

Particle-Size Analysis of Soils
ASTM D 422

Project Name: Clifty Creek IKEC CCR Rule Eng
Project Number: 175534018
Source: BKG-2-29-35, 29.0'-35.0'
Lab ID: 4

Sieve analysis for the Portion Coarser than the No. 10 Sieve

Test Method: ASTM D 422
Prepared using: ASTM D 421

Particle Shape: Angular
Particle Hardness: Hard and Durable

Tested By: TA
Test Date: 07-27-2015
Date Received: 07-23-2015

Maximum Particle size: 3/4" Sieve

Sieve Size	% Passing
3/4"	100.0
3/8"	98.6
No. 4	98.1
No. 10	96.8

Analysis for the portion Finer than the No. 10 Sieve

Analysis Based on -3 inch fraction only

Specific Gravity: 2.7

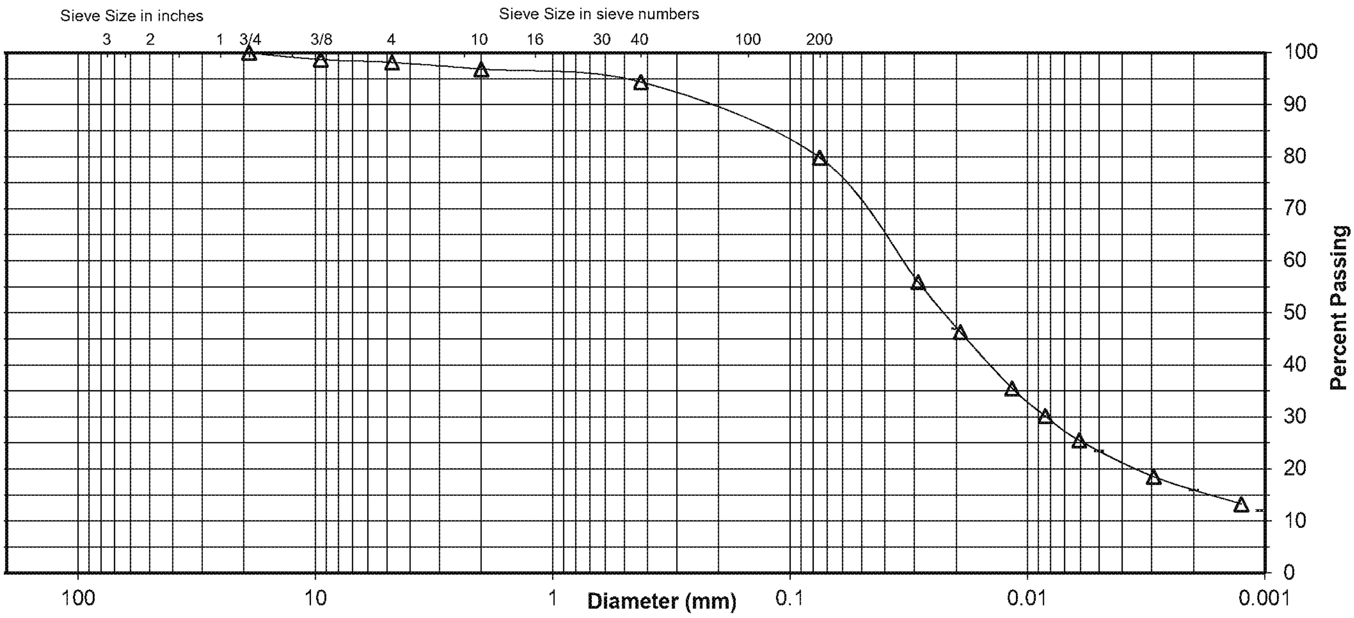
Dispersed using Apparatus A - Mechanical, for 1 minute

No. 40	94.3
No. 200	79.8
0.02 mm	46.9
0.005 mm	23.4
0.002 mm	16.0
0.001 mm	12.0

Particle Size Distribution

ASTM	Coarse Gravel	Fine Gravel	C. Sand	Medium Sand	Fine Sand	Silt	Clay
	0.0	1.9	1.3	2.5	14.5	56.4	23.4

AASHTO	Gravel	Coarse Sand	Fine Sand	Silt	Clay
	3.2	2.5	14.5	63.8	16.0



Comments ______

Reviewed By RJ

APPENDIX B

BORING & WELL LOGS

BORING NO. CF-15-04

SAMPLE/CORE LOG

Project Number:	2015067	Log Page	1 of 1
Project Location:	Clifty Creek Plant Landfill Northeast End	Drilling Contractor:	Bowser Morner
Drilling Date(s):	12/3/15	AGES Geologist:	Mike Gelles

Drilling Method:	Roto-Sonic	Coring Device Size:	NA	Hammer Wt.	NA	and Drop	NA
Sampling Method:	NA	Borehole Diameter:	6”	Drilling Fluid Used:	Water		
Sampling Interval:	NA	Borehole Depth:	40’	Surface Elevation:	465.55’ MSL		

NOTES/COMMENTS:

Depth Interval (feet)	Sample Recovery (feet)	Penetration (Hyd. Pres. or Blow Counts)	Sample/Core Description	PID (PPM)
0-10	7	NA	0-4’ Boiler slag, clay, fine sand, moist, fill; 4’-7’ gray silty clay, trace gravel, stiff, plastic, moist	N/A
10-20	9	NA	Orange brown silty clay, fine sand, gray mottling, stiff, plastic, moist	N/A
20-30	10	NA	20’-24’ Orange brown silty clay, fine sand, gray mottling, stiff, plastic, moist; 24’-29’ gray brown silty clay, fine sand, stiff, plastic, wet; 29’-30’ gray brown silty clay, fine sand, stiff, plastic, moist	N/A
30-40	10	NA	30’-36’ Orange brown silty clay, fine and medium sand, gravel, stiff, plastic, wet; 36’-40’ brown gray silty clay, trace gravel, stiff, plastic, moist, till	N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A

WELL CONSTRUCTION LOG
WELL NO. CF-15-04

Project Number: 2015067

Project Location: Clifty Creek Plant – Landfill Northeast End

Installation Date(s): 12/3/15

Drilling Method: Roto-Sonic

Drilling Contractor: Bowser Morner

Development Date(s): 12/9/15

Development Method: Submersible Pump

Field parameters stabilized.

Turbidity = 0.91 NTUs

Volume Purged: 65 gallons

Static Water-Level* 28.53’

Top of Well Casing Elevation: 468.03’

Well Purpose:

Groundawter Monitoring

Northing (Y): 451482.81

Easting (X): 569307.19

Comments/Notes:

2 inch PVC riser and screen

10 ft of 0.010 pre-packed well screen with an inner filter pack of 0.40 mm clean quartz sand and an outer layer of food-grade nylon mesh.

Inspector: Michael Gelles

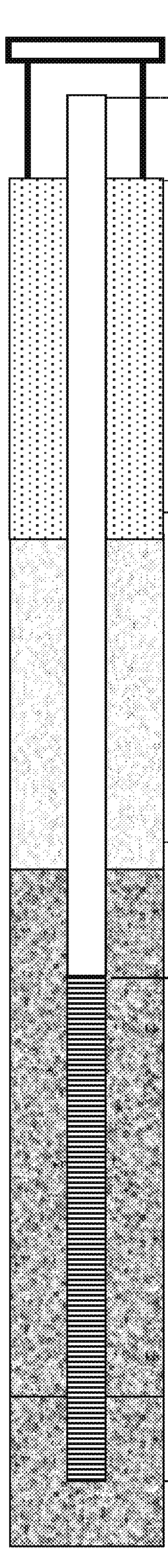
CONSTRUCTION MATERIALS USED:

6 Bags of Sand

2 Bags/Buckets Bentonite Pellets

6 Bags Portland for Grout

Bags Concrete/Sakrete



Protective Casing with Locking Cap

Top of Casing Elevation: 468.03 ft.

Stick-up: 2.48 ft.

Land Surface Elevation: 465.55 ft.

Grout; Type: Portland cement/ Grout

Borehole Diameter: 6 inch

Casing Diameter: 2 Inch

Casing Material: PVC

Top of Seal: 20 ft*

Seal Type: Bentonite Pellets/Chips

Top of Sand/Gravel Pack: 24 ft*

Top of Well Screen 26 ft*

Sand/Gravel Pack; Type: Global #5

Screen Diameter: 2 Inch

Screen Slot-Size: 0.010 Inch

Screen Material: PVC

Bottom of Well Screen 36 ft.*

Base of Borehole: 40 ft.*

Total Depth of Well Below Top of Casing: 38.48 ft.

*Indicates Depth Below Land Surface

BORING NO. CF-15-05
SAMPLE/CORE LOG

Project Number:	2015067	Log Page	1 of 1
Project Location:	Clifty Creek Plant Landfill South End	Drilling Contractor:	Bowser Morner
Drilling Date(s):	11/29/15-11/30/15	AGES Geologist:	Joe Webster

Drilling Method:	HSA	Coring Device Size:	NA	Hammer Wt.	160lb	and Drop	2ft
Sampling Method:	NA	Borehole Diameter:	4.25"	Drilling Fluid Used:	Water		
Sampling Interval:	NA	Borehole Depth:	27'	Surface Elevation:	439.85' MSL		

NOTES/COMMENTS:

Depth Interval (feet)	Sample Recovery (feet)	Penetration (Hyd. Pres. or Blow Counts)	Sample/Core Description	PID (PPM)
0-10		NA	Advance augers – no samples	N/A
10-12	2	2-2-2-2	Brown clay, little silt, very moist to wet	N/A
12-14	2	1-2-2-3	Brown clay, little silt, wet.	N/A
14-16	2	2-2-2-2	Brown clay, little silt, very moist to wet	N/A
16-18	2	2-3-2-2	Brown to olive gray clay, little silt, trace sand, very moist to wet	N/A
18-20	1.33	1-1-2-1	Olive gray clay, some silt, wet	N/A
20-22	2	2-2-3-2	Olive gray clay, some silt, wet	N/A
22-24	2	WH-WH-2-2	Gray clay, some silt, trace fine sand, moist to wet	N/A
24-26	2	1-1-2-2	Gray clay, some silt, trace fine sand, moist	N/A
26-27	0.1	10-50/1	Brown to gray weathered shale with limestone	N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A

WELL CONSTRUCTION LOG
WELL NO. CF-15-05

Project Number: 2015067

Project Location: Clifty Creek Plant – Landfill South End

Installation Date(s): 11/29/15-12/1/15

Drilling Method: Hollow Stem Auger

Drilling Contractor: Bowser Morner

Development Date(s): 12/16/15

Development Method: Peristaltic Pump, Bailer
Field parameters stabilized.
Turbidity = 4.28 NTUs

Volume Purged: 46 gallons

Static Water-Level*: 11.23'

Top of Well Casing Elevation: 442.58'

Well Purpose:
Groundawter Monitoring
Northing (Y): 447491.91
Easting (X): 565533.64

Comments/Notes:
2 inch PVC riser and screen
10 ft of 0.010 pre-packed well screen with an inner filter pack of 0.40 mm clean quartz sand and an outer layer of food-grade nylon mesh.

Inspector: Joe Webster

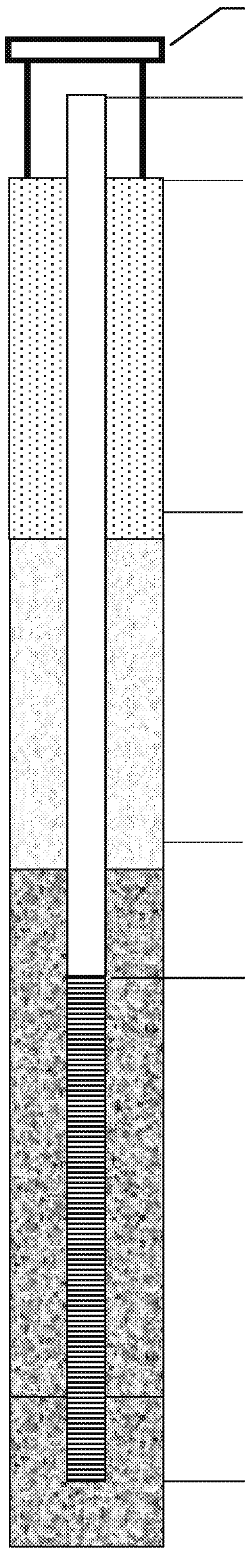
CONSTRUCTION MATERIALS USED:

_____ Bags of Sand

_____ Bags/Buckets Bentonite Pellets

_____ Bags Portland for Grout

_____ Bags Concrete/Sakrete



Protective Casing with Locking Cap

Top of Casing Elevation: 442.58 ft.
Stick-up: 2.73 ft.

Land Surface Elevation: 439.85 ft.

Grout; Type: Portland cement/Grout

Borehole Diameter: 4.25 inch

Casing Diameter: 2 Inch
Casing Material: PVC
Top of Seal: 5 ft*

Seal Type: Bentonite Pellets/Chips

Top of Sand/Gravel Pack: 15 ft*

Top of Well Screen 17 ft*

Sand/Gravel Pack; Type: Global #5

Screen Diameter: 2 Inch
Screen Slot-Size: 0.010 Inch
Screen Material: PVC

Bottom of Well Screen 27 ft.*

Base of Borehole: 27 ft.*

Total Depth of Well Below Top of Casing: 29.73 ft.

*Indicates Depth Below Land Surface

BORING NO. CF-15-06
SAMPLE/CORE LOG

Project Number:	2015067	Log Page	1 of 1
Project Location:	Clifty Creek Plant Landfill South End	Drilling Contractor:	Bowser Morner
Drilling Date(s):	11/29/15-11/30/15	AGES Geologist:	Joe Webster

Drilling Method:	HSA	Coring Device Size:	NA	Hammer Wt.	160lb and Drop 2ft
Sampling Method:	NA	Borehole Diameter:	4.25”	Drilling Fluid Used:	Water
Sampling Interval:	NA	Borehole Depth:	16’	Surface Elevation:	437.49’ MSL

NOTES/COMMENTS:

Depth Interval (feet)	Sample Recovery (feet)	Penetration (Hyd. Pres. or Blow Counts)	Sample/Core Description	PID (PPM)
0-10		NA	Advance augers – no samples	N/A
10-12	1.5	3-3-3-5	Brown clay, some silt, soft, moist	N/A
12-14	1.7	3-3-4-3	Brown clay, little silt, soft, moist	N/A
14-16	0.8	4-7-46-50/4	Gray to brown, weathered shale with limestone, hard, dry	N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A

WELL CONSTRUCTION LOG
WELL NO. CF-15-06

Project Number: 2015067

Project Location: Clifty Creek Plant – Landfill South End

Installation Date(s): 11/29/15-11/30/15

Drilling Method: Hollow Stem Auger

Drilling Contractor: Bowser Morner

Development Date(s): 12/16/15

Development Method: Peristaltic Pump, Bailer

Field parameters stabilized.

Turbidity = 5.59 NTUs

Volume Purged: 6.95 gallons

Static Water-Level* 17.65'

Top of Well Casing Elevation: 440.40'

Well Purpose:

Groundwater Monitoring

Northing (Y): 447026.92

Easting (X): 565190.31

Comments/Notes:

2 inch PVC riser and screen

10 ft of 0.010 pre-packed well screen with an inner filter pack of 0.40 mm clean quartz sand and an outer layer of food-grade nylon mesh.

Inspector: Joe Webster

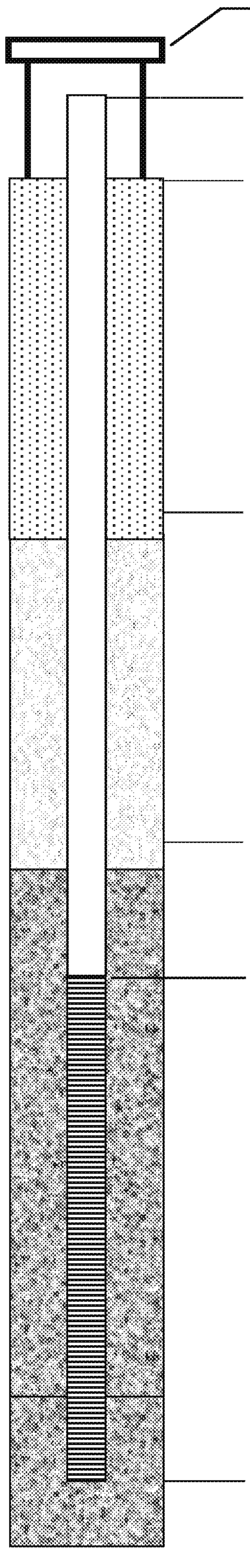
CONSTRUCTION MATERIALS USED:

______ Bags of Sand

______ Bags/Buckets Bentonite Pellets

______ Bags Portland for Grout

______ Bags Concrete/Sakrete



Protective Casing with Locking Cap

Top of Casing Elevation: 440.40 ft.

Stick-up: 2.91 ft.

Land Surface Elevation: 437.49 ft.

Grout; Type: Portland cement/ Grout

Borehole Diameter: 4.25 inch

Casing Diameter: 2 Inch

Casing Material: PVC

Top of Seal: 2 ft*

Seal Type: Bentonite Pellets/Chips

Top of Sand/Gravel Pack: 5 ft*

Top of Well Screen 6 ft*

Sand/Gravel Pack; Type: Global #5

Screen Diameter: 2 Inch

Screen Slot-Size: 0.010 Inch

Screen Material: PVC

Bottom of Well Screen 16 ft.*

Base of Borehole: 16 ft.*

Total Depth of Well Below Top of Casing: 18.91 ft.

*Indicates Depth Below Land Surface

BORING NO. CF-15-07
SAMPLE/CORE LOG

Project Number:	2015067	Log Page	1 of 1
Project Location:	Clifty Creek Plant Landfill South End	Drilling Contractor:	Bowser Morner
Drilling Date(s):	11/19/15-11/23/15	AGES Geologist:	Joe Webster

Drilling Method:	HSA	Coring Device Size:	NA	Hammer Wt.	160lb. and Drop 2ft
Sampling Method:	NA	Borehole Diameter:	4.25”	Drilling Fluid Used:	Water
Sampling Interval:	NA	Borehole Depth:	16’	Surface Elevation:	438.61’ MSL

NOTES/COMMENTS:

Depth Interval (feet)	Sample Recovery (feet)	Penetration (Hyd. Pres. or Blow Counts)	Sample/Core Description	PID (PPM)
0-10		NA	Advance augers – no samples	N/A
10-12	1	1-1-3-5	Brown silty clay, stiff, plastic, wet	N/A
12-14	0	NA	No recovery	N/A
14-16	1.35	3-2-2-2	Brown gray silty clay with mottling, trace gravel, stiff, moist	N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A

WELL CONSTRUCTION LOG
WELL NO. CF-15-07

Project Number: 2015067

Project Location: Clifty Creek Plant – Landfill South End

Installation Date(s): 11/23/15

Drilling Method: Hollow Stem Auger
Drilling Contractor: Bowser Morner

Development Date(s): 12/15/15

Development Method: Peristaltic Pump, Bailer
Field parameters stabilized.
Turbidity = 4.42 NTUs

Volume Purged: 12.5 gallons

Static Water-Level* 5.92'

Top of Well Casing Elevation: 441.11'

Well Purpose:
Groundwater Monitoring
Northing (Y): 443135.08
Easting (X): 562259.25

Comments/Notes:
2 inch PVC riser and screen
10 ft of 0.010 pre-packed well screen with an inner filter pack of 0.40 mm clean quartz sand and an outer layer of food-grade nylon mesh.

Inspector: Joe Webster

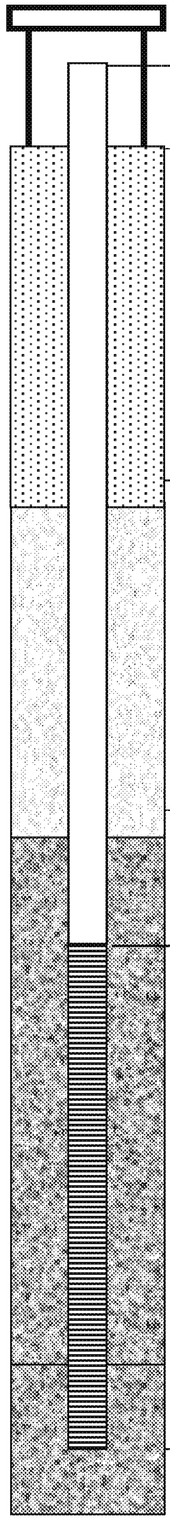
CONSTRUCTION MATERIALS USED:

_____ Bags of Sand

_____ Bags/Buckets Bentonite Pellets

_____ Bags Portland for Grout

_____ Bags Concrete/Sakrete



Protective Casing with Locking Cap

Top of Casing Elevation: 441.11 ft.
Stick-up: 2.50 ft.

Land Surface Elevation: 438.61 ft.

Grout; Type: Portland cement/Grout

Borehole Diameter: 4.25 inch

Casing Diameter: 2 Inch
Casing Material: PVC
Top of Seal: 2 ft*

Seal Type: Bentonite Pellets/Chips

Top of Sand/Gravel Pack: 5 ft*

Top of Well Screen 6 ft*

Sand/Gravel Pack; Type: Global #5

Screen Diameter: 2 Inch
Screen Slot-Size: 0.010 Inch
Screen Material: PVC

Bottom of Well Screen 16 ft.*

Base of Borehole: 16 ft.*

Total Depth of Well
Below Top of Casing: 18.50 ft.

*Indicates Depth Below Land Surface

BORING NO. CF-15-08
SAMPLE/CORE LOG

Project Number:	2015067	Log Page	1 of 1
Project Location:	Clifty Creek Plant Landfill South End	Drilling Contractor:	Bowser Morner
Drilling Date(s):	11/17/15-11/19/15	AGES Geologist:	Mike Gelles

Drilling Method:	HSA	Coring Device Size:	NA	Hammer Wt. 160lb	and Drop 2ft
Sampling Method:	NA	Borehole Diameter:	4.25"	Drilling Fluid Used:	Water
Sampling Interval:	NA	Borehole Depth:	40'	Surface Elevation:	460.33' MSL

NOTES/COMMENTS:

Depth Interval (feet)	Sample Recovery (feet)	Penetration (Hyd. Pres. or Blow Counts)	Sample/Core Description	PID (PPM)
0-10		NA	Advance augers – no samples	N/A
10-12	2	3-6-6-7	Orange brown silty clay, fine sand, slightly plastic, moist	N/A
12-14	1.4	5-7-10-10	Light brown silt, loose, moist	N/A
14-16	1.6	4-8-12-10	Light brown silt, loose, moist	N/A
16-18	1.6	7-6-9-7	Light brown silt, loose, moist	N/A
18-20	1.6	3-6-4-4	18'-19' Light brown silt, loose, moist; 19'20' Light brown silt, loose, wet	N/A
20-22	1.2	2-3-6-6	Light brown silt, trace clay, wet	N/A
22-24	0.1	2-3-3-3	Brown silt, clay, wet	N/A
24-26	2	2-4-6-7	Brown silt, clay, wet	N/A
26-28	2	3-5-5-5	Brown fine and medium sand, trace silt, trace clay, wet	N/A
28-30	2	3-5-9-12	Brown fine and medium sand, trace silt, trace clay, wet	N/A
30-32	1.2	1-2-2-2	Brown fine and medium sand, medium gravel, trace silt, trace clay, wet	N/A
32-34	2	4-5-5-9	Brown fine and medium sand, fine and medium gravel, trace silt, trace clay, wet	N/A
34-36	2	WH-3-6-8	Brown fine and medium sand, fine and medium gravel, trace silt, trace clay, wet	N/A
36-38	2	4-5-7-8	Brown fine and medium sand, fine and medium gravel, trace silt, trace clay, wet	N/A
38-40	2	3-5-5-11	38'-39.75' Brown fine and medium sand, fine and medium gravel, trace silt, trace clay, wet; 39.75'-40' gray fine and medium sand, silt, trace clay, wet	N/A

WELL CONSTRUCTION LOG
WELL NO. CF-15-08

Project Number: 2015067

Project Location: Clifty Creek Plant – Landfill South End

Installation Date(s): 11/17/15-11/19/15

Drilling Method: Hollow stem Auger

Drilling Contractor: Bowser Morner

Development Date(s): 12/8/15

Development Method: Submersible Pump

Field parameters stabilized.

Turbidity = 2.16 NTUs

Volume Purged: 100 gallons

Static Water-Level*: 24.31’

Top of Well Casing Elevation: 462.79’

Well Purpose:

Groundwater Monitoring

Northing (Y): 443219.57

Easting (X): 562537.29

Comments/Notes:

2 inch PVC riser and screen

10 ft of 0.010 pre-packed well screen with an inner filter pack of 0.40 mm clean quartz sand and an outer layer of food-grade nylon mesh.

Inspector: Michael Gelles

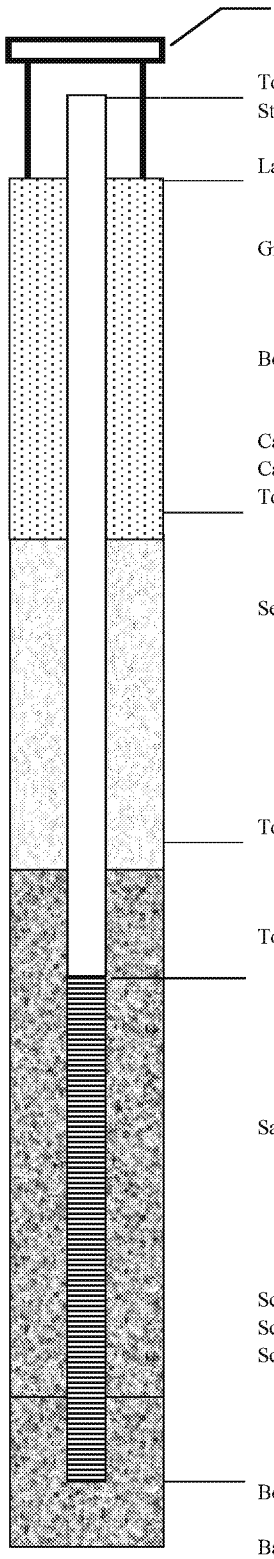
CONSTRUCTION MATERIALS USED:

4.5 Bags of Sand

0.5 Bags/Buckets Bentonite Pellets

3 Bags Portland for Grout

____ Bags Concrete/Sakrete



Protective Casing with Locking Cap

Top of Casing Elevation: 462.79 ft.

Stick-up: 2.46 ft.

Land Surface Elevation: 460.33 ft.

Grout; Type: Portland cement/ Grout

Borehole Diameter: 4.25 inch

Casing Diameter: 2 Inch

Casing Material: PVC

Top of Seal: 24 ft*

Seal Type: Bentonite Pellets/Chips

Top of Sand/Gravel Pack: 28 ft*

Top of Well Screen 30 ft*

Sand/Gravel Pack; Type: Global #5

Screen Diameter: 2 Inch

Screen Slot-Size: 0.010 Inch

Screen Material: PVC

Bottom of Well Screen 40 ft.*

Base of Borehole: 40 ft.*

Total Depth of Well Below Top of Casing: 42.46 ft.

*Indicates Depth Below Land Surface

BORING NO. CF-15-09
SAMPLE/CORE LOG

Project Number:	2015067	Log Page	1 of 1
Project Location:	Clifty Creek Plant Landfill South End	Drilling Contractor:	Bowser Morner
Drilling Date(s):	11/24/15-11/25/15	AGES Geologist:	Joe Webster

Drilling Method:	HSA	Coring Device Size:	NA	Hammer Wt.	NA	and Drop	NA
Sampling Method:	NA	Borehole Diameter:	4.25"	Drilling Fluid Used:	Water		
Sampling Interval:	NA	Borehole Depth:	14'	Surface Elevation:	456.73' MSL		

NOTES/COMMENTS:

Depth Interval (feet)	Sample Recovery (feet)	Penetration (Hyd. Pres. or Blow Counts)	Sample/Core Description	PID (PPM)
0-10		NA	Advance augers – no samples	N/A
10-12	1.8	5-9-6-9	Brown weathered shale wilt limestone, hard, dry	N/A
12-14	0.2	50/4	Brown weathered shale wilt limestone, hard, dry	N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A

WELL CONSTRUCTION LOG
WELL NO. CF-15-09

Project Number: 2015067

Project Location: Clifty Creek Plant – Landfill South End

Installation Date(s): 11/24/15-11/25/15

Drilling Method: Hollow Stem Auger

Drilling Contractor: Bowser Morner

Development Date(s): 12/16/15

Development Method: Peristaltic Pump, Bailer
Field parameters stabilized.
Turbidity = 3.21 NTUs

Volume Purged: 6 gallons

Static Water-Level*: 12.18'

Top of Well Casing Elevation: 459.45'

Well Purpose:
Groundwater Monitoring
Northing (Y): 443445.96
Easting (X): 562871.69

Comments/Notes:
2 inch PVC riser and screen
5 ft of 0.010 pre-packed well screen with an inner filter pack of 0.40 mm clean quartz sand and an outer layer of food-grade nylon mesh.

Inspector: Joe Webster

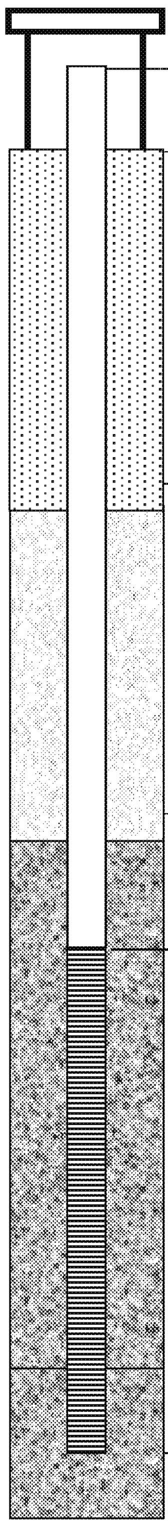
CONSTRUCTION MATERIALS USED:

_____ Bags of Sand

_____ Bags/Buckets Bentonite Pellets

_____ Bags Portland for Grout

_____ Bags Concrete/Sakrete



Protective Casing with Locking Cap

Top of Casing Elevation: 459.45 ft.
Stick-up: 2.72 ft.

Land Surface Elevation: 456.73 ft.

Grout; Type: Portland cement/Grout

Borehole Diameter: 4.25 inch

Casing Diameter: 2 Inch
Casing Material: PVC
Top of Seal: 1 ft*

Seal Type: Bentonite Pellets/Chips

Top of Sand/Gravel Pack: 6 ft*

Top of Well Screen 9 ft*

Sand/Gravel Pack; Type: Global #5

Screen Diameter: 2 Inch
Screen Slot-Size: 0.010 Inch
Screen Material: PVC

Bottom of Well Screen 14 ft.*

Base of Borehole: 14 ft.*

Total Depth of Well Below Top of Casing: 16.72 ft.

*Indicates Depth Below Land Surface

BORING NO. WAP -1
SAMPLE/CORE LOG

Project Number:	P200852	Log Page	1 of 1
Project Location:	Clifty Creek- West Boiler Slag Pond	Drilling Contractor:	Stan Tec
Drilling Date(s):	7-8-15	AGES Geologist:	Mike Gelles

Drilling Method:	HSA	Coring Device Size:	NA	Hammer Wt.	NA	and Drop	NA
Sampling Method:	NA	Borehole Diameter:		Drilling Fluid Used:	None		
Sampling Interval:	NA	Borehole Depth:		Surface Elevation:			

NOTES/COMMENTS:

Depth Interval (feet)	Sample Recovery (feet)	Penetration (Hyd. Pres. or Blow Counts)	Sample/Core Description	PID (PPM)
0-2	1.5	4-9-16-32	Brown/black silt and fine sand, bottom ash, coal dust, moist	N/A
2-4	1.7	9-21-42-46	Brown/black silt and fine sand, coal dust, moist	N/A
4-6	1.8	12-27-28-25	Brown/black silt, sand, boiler slag, moist	N/A
6-8	1.8	2-7-3-4	Top 1.1' Brown/black boiler slag, silt, fine sand, moist, stiff Bottom 0.7' Brown gray clay, moist, stiff	N/A
8-10	1.6	2-3-6-8	Brown grey silty clay, moist	N/A
10-12	2.0	2-3-6-9	Brown grey to brown, silty clay, moist, stiff	N/A
12-14	2.0	3-4-8-11	Brown silty clay, moist, stiff	N/A
14-16	2.0	3-3-7-9	Brown silty clay moist, stiff	N/A
16-18	2.0	1-2-4-15	Top 1.7' Brown silty clay ,very moist, stiff Bottom 0.3' Rock (limestone), fragments of bedrock	N/A
18-20	1.7	20-6-13-17	Brown Silty clay, moist, stiff, layers of limestone, 20'refusal 50 blows on limestone bedrock.	N/A
20	0	50/0	Refusal – limestone bedrock	N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A

Project No: 2015078 HMI Inspector: Mike Gelles Page 2 of 2

BORING NO. BKG-2
SAMPLE/CORE LOG

Project Number:	P200852	Log Page	1 of 1
Project Location:	Clifty Creek-Background-2	Drilling Contractor:	Stan Tec
Drilling Date(s):	7-8-15	AGES Geologist:	Mike Gelles

Drilling Method:	HSA	Coring Device Size:	NA	Hammer Wt.	NA	and Drop	NA
Sampling Method:	NA	Borehole Diameter:		Drilling Fluid Used:	None		
Sampling Interval:	NA	Borehole Depth:		Surface Elevation:			

NOTES/COMMENTS: Sample collected for grain size analysis @ 29.0 – 35.0’

Depth Interval (feet)	Sample Recovery (feet)	Penetration (Hyd. Pres. or Blow Counts)	Sample/Core Description	PID (PPM)
0-15	N/A	N/A	Brown silty clay, moist	N/A
15-17	100%	2-3-3-4	Brown, silty clay, moist, slightly plastic	N/A
17-19	100%	3-1-2-2	Brown, silty clay, moist, slightly plastic	N/A
19-21	100%	3-3-3-5	Brown, silty clay, moist, plastic	N/A
21-23	100%	1-2-2-5	Brown, silty clay, moist, plastic	N/A
23-25	100%	2-5-4-5	Brown, silty clay, moist, plastic	N/A
25-27	100%	3-5-8-15	Brown, silty clay, moist, plastic	N/A
27-29	100%	10-8-5-6	Brown, silty clay, moist, plastic	N/A
29-31	100%	4-6-11-9	Top 1.0’ Brown fine & medium sand, silt wet Bottom 1.0’ Gray clay trace silt, stiff, moist	N/A
31-33	100%	6-6-6-6	Gray silt, trace clay, wet	N/A
33-35	100%	3-5-4-6	Gray silt, trace clay, wet	N/A

BORING NO. WAP -2
SAMPLE/CORE LOG

Project Number:	P200852	Log Page	1 of 1
Project Location:	Clifty Creek- West Boiler Slag Pond	Drilling Contractor:	Stan Tec
Drilling Date(s):	7-9-15	AGES Geologist:	Mike Gelles

Drilling Method:	HSA	Coring Device Size:	NA	Hammer Wt.	NA	and Drop	NA
Sampling Method:	NA	Borehole Diameter:		Drilling Fluid Used:	None		
Sampling Interval:	NA	Borehole Depth:		Surface Elevation:			

NOTES/COMMENTS: Sample collected for grain size analysis @ 51.0 – 61.0'

Depth Interval (feet)	Sample Recovery (feet)	Penetration (Hyd. Pres. or Blow Counts)	Sample/Core Description	PID (PPM)
0-10	N/A	N/A	Red brown silty clay, gravel, moist	N/A
10-35	N/A	N/A	Red brown silty clay, some gravel, moist	N/A
35-37	No recovery	3-6-8-11	No description	N/A
37-39	1.9	3-6-9-10	Brown silty clay, moist, trace gravel	N/A
39-41	1.9	WOH-3-7-9	Brown gray silt clay, moist, trace sand	N/A
41-43	2.0	2-3-3-5	Brown gray silt, clay, moist	N/A
43-45	1.8	1-1-2-4	Brown gray silt, clay, moist	N/A
45-47	2.0	WOH-2-1-3	Brown gray silt, clay, moist	N/A
47-49	1.9	WOH-1-3-3	Brown gray silt, clay, moist	N/A
49-51	1.9	WOH-2-1-3	Brown gray silt, clay, moist	N/A
51-53	1.9	WOH-2-1-4	Brown gray silt, clay, wet	N/A
53-55	2.0	WOH-1-3-3	Brown gray silt, clay, wet	N/A
55-57	2.0	1-2-4-7	Brown gray silt, clay, wet	N/A
57-59	2.0	1-1-2-3	Brown gray silt, clay, wet	N/A
59-61	2.0	1-1-4-8	Brown gray silt, clay, wet	N/A
				N/A

BORING NO. BKG -1
SAMPLE/CORE LOG

Project Number:	P200852	Log Page	1 of 1
Project Location:	Clifty Creek- Background-1	Drilling Contractor:	Stan Tec
Drilling Date(s):	7-9-15, 7-10-15	AGES Geologist:	Mike Gelles

Drilling Method:	HSA	Coring Device Size:	NA	Hammer Wt.	NA	and Drop	NA
Sampling Method:	NA	Borehole Diameter:		Drilling Fluid Used:	None		
Sampling Interval:	NA	Borehole Depth:		Surface Elevation:			

NOTES/COMMENTS:

Depth Interval (feet)	Sample Recovery (feet)	Penetration (Hyd. Pres. or Blow Counts)	Sample/Core Description	PID (PPM)
0-2	1.6	3-6-15-15	Gravel, brown sandy clay, moist (Fill)	N/A
2-4	0.5	6-5-4-3	Gravel, brown sandy clay, moist (Fill)	N/A
4-6	1.9	3-2-2-4	Gravel, brown sandy clay and silty clay, moist (Fill)	N/A
6-8	1.2	4-2-3-8	Gravel, brown sandy clay, moist	N/A
8-10	1.6	4-5-4-5	Brown silty clay, moist and sandy clay, rock fragments.	N/A
10-12	1.6	8-5-5-8	Brown sandy clay, rock fragments, moist	N/A
12-14	1.4	8-2-6-9	Brown sandy clay gravel (fill) wet	N/A
14-16	1.0	2-2-1-3	Brown sandy clay, rock fragments, moist	N/A
16-18	0.5	1-2-5-50	Brown sand clay, rock fragments, wet, bedrock 17.5 to 17.8 Refusal on limestone.	N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A

BORING NO. BKG-3
SAMPLE/CORE LOG

Project Number:	P200852	Log Page	1 of 1
Project Location:	Clifty Creek- Background-3	Drilling Contractor:	Stan Tec
Drilling Date(s):	7-15-15	AGES Geologist:	Mike Gelles

Drilling Method:	HSA	Coring Device Size:	NA	Hammer Wt.	NA	and Drop	NA
Sampling Method:	NA	Borehole Diameter:		Drilling Fluid Used:	None		
Sampling Interval:	NA	Borehole Depth:		Surface Elevation:			

NOTES/COMMENTS: Sample collected for grain size analysis @ 33.0 – 43.0'

Depth Interval (feet)	Sample Recovery (feet)	Penetration (Hyd. Pres. or Blow Counts)	Sample/Core Description	PID (PPM)
0-5	N/A	N/A	Gravel, ash, silty clay brown, black, moist	N/A
5-13	N/A	N/A	Brown gray silty clay, moist	N/A
13-15	N/A	N/A	Brown gray silty clay, moist, fine sand ,wet	N/A
15-20	N/A	N/A	Brown gray silty clay, fine sand, moist	N/A
20-25	N/A	N/A	Brown gray silty clay, fine sand, moist	N/A
25-27	1.0	11-5-15-24	Brown orange silty clay, rock fragments, wet	N/A
27-29	1.0	10-20-18-13	Brown orange sand fine & medium, gravel round, moist, rock fragments	N/A
29-31	1.0	8-20-19-28	Brown tan sand fine & medium, silt, moist to wet	N/A
31-33	2.0	7-50/2	Brown tan sand fine & medium, silt, wet, weathered limestone (from above, not true interval)	N/A
33-35	0.8	10-5-5-6	Top 0.5' Brown orange silt moist Bottom 0.3' Gray brown silt, saturated	N/A
35-37	1.5	4-2-2-3	Brown gray silt, wet	N/A
37-39	1.5	2-1-3-3	Brown gray silt, clay, wet	N/A
39-41	1.8	1-3-4-4	Brown gray silt, clay, wet	N/A
41-43	1.8	1-2-3-5	Brown gray silt, clay ,wet	N/A
				N/A
				N/A
				N/A

Project No: 2015078 HMI Inspector: Mike Gelles

BORING NO. Downgradient SW
SAMPLE/CORE LOG

Project Number:	P200852	Log Page	1 of 1
Project Location:	Clifty Creek Landfill– Downgradient SW	Drilling Contractor:	Stan Tec
Drilling Date(s):	7-8-15	AGES Geologist:	Mike Gelles

Drilling Method:	HSA	Coring Device Size:	NA	Hammer Wt.	NA	and Drop	NA
Sampling Method:	NA	Borehole Diameter:		Drilling Fluid Used:	None		
Sampling Interval:	NA	Borehole Depth:		Surface Elevation:			

NOTES/COMMENTS: Samples collected for grain size analysis @ 24.0 – 34.0'

Depth Interval (feet)	Sample Recovery (feet)	Penetration (Hyd. Pres. or Blow Counts)	Sample/Core Description	PID (PPM)
0-5	N/A	N/A	Very moist clay, brown with some silt	N/A
5-10	N/A	N/A	Moist-damp, brown, stiff clay, no gravel, some silt	N/A
10-15	N/A	N/A	Very moist, brown with some grey clay, trace silt, no sand or gravel	N/A
15-20	N/A	N/A	Very moist- wet, brown with some gray, clay and silt with some very fine sand no gravel	N/A
20-22	2.0	1-1-2-2	Upper 0.8' Very moist brown silty clay with sand; Lower 1.2' wet/saturated brown silt & very fine sand	N/A
22-24	1.6	WOH/12-1/12	Saturated, brown, very fine sandy silt, free water in spoon	N/A
24-26	2.0	1/12-1-1	Upper 1.8' Saturated, brown, very fine sandy silt, free water in spoon; Lower 0.2' Saturated, brown sand with silt and some fine gravel	N/A
26-28	1.0	WOH – 1/18	Saturated, brown loose silty sand with trace clay, no gravel	N/A
28-30	1.7	WHO-1-2-4	Saturated, brown fine sand with silt and few 3/8" pieces of gravel, few small clay areas	N/A
30-32	1.2	1-4-9-10	Upper 0.5' Brown silt, clay and sand, firm; Lower 0.7' Saturated, brown, fine sand, silt, with some clay and gravel, compacted	N/A
32-34	0.5	6-10-11-15	Poor recovery, large gravel in shoe, brown wet silty fine sand	N/A
34-36	1.5	4-4-5-10	Saturated brown sand all sizes and some small gravel, with 1-2" silt lense and few small clay areas; 15% silt throughout	N/A
36-38	1.6	1-4-10-12	Saturated, brown sand all sizes, mostly fine with silt and gravel; Lower 0.6' dense	N/A
38-40	1.5	3-6-7-10	Wet, brown, sand with silt and gravel and some clay, compacted	N/A
				N/A

Project No: 2015078 HMI Inspector: Mike Gelles

				N/A

BORING NO. WBSP-15-01
SAMPLE/CORE LOG

Project Number:	2015067	Log Page	1 of 1
Project Location:	Clifty Creek Plant West Boiler Slag Pond	Drilling Contractor:	Bowser Morner
Drilling Date(s):	11/30/15	AGES Geologist:	Mike Gelles

Drilling Method:	Roto-Sonic	Coring Device Size:	NA	Hammer Wt.	NA	and Drop	NA
Sampling Method:	NA	Borehole Diameter:	6”	Drilling Fluid Used:	Water		
Sampling Interval:	NA	Borehole Depth:	18’	Surface Elevation:	466.93’ MSL		

NOTES/COMMENTS:

Depth Interval (feet)	Sample Recovery (feet)	Penetration (Hyd. Pres. or Blow Counts)	Sample/Core Description	PID (PPM)
0-10	8	NA	Yellow brown silty clay, stiff, plastic, moist	N/A
10-18	8	NA	10’-15’ Yellow brown silty clay, stiff, plastic, moist; 12’-14’ wet; 15’18’ Light gray limestone	N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A

WELL CONSTRUCTION LOG
WELL NO. WBSP-15-01

Project Number: 2015067

Project Location: Clifty Creek Plant – West Boiler Slag Pond

Installation Date(s): 11/30/15

Drilling Method: Roto-Sonic

Drilling Contractor: Bowser Morner

Development Date(s): 12/16/15

Development Method: Submersible Pump, Peristaltic Pump, Bailer

Field parameters stabilized.

Turbidity = 3.12 NTUs

Volume Purged: 33 gallons

Static Water-Level*: 16.76'

Top of Well Casing Elevation: 469.36'

Well Purpose:

Groundwater Monitoring

Northing (Y): 449072.27

Easting (X): 566322.12

Comments/Notes:

2 inch PVC riser and screen

10 ft of 0.010 pre-packed well screen with an inner filter pack of 0.40 mm clean quartz sand and an outer layer of food-grade nylon mesh.

Inspector: Michael Gelles

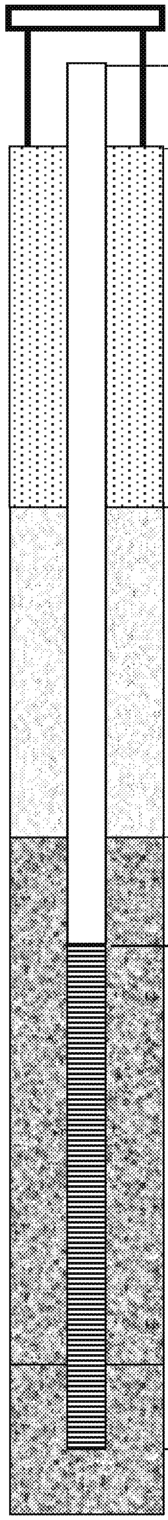
CONSTRUCTION MATERIALS USED:

4 Bags of Sand

2 Bags/Buckets Bentonite Pellets

Bags Portland for Grout

Bags Concrete/Sakrete



Protective Casing with Locking Cap

Top of Casing Elevation: 469.36 ft.

Stick-up: 2.43 ft.

Land Surface Elevation: 466.93 ft.

Grout; Type: Potland cement/Grout

Borehole Diameter: 6 inch

Casing Diameter: 2 Inch

Casing Material: PVC

Top of Seal: 2 ft*

Seal Type: Bentonite Pellets/Chips

Top of Sand/Gravel Pack: 6 ft*

Top of Well Screen 8 ft*

Sand/Gravel Pack; Type: Global #5

Screen Diameter: 2 Inch

Screen Slot-Size: 0.010 Inch

Screen Material: PVC

Bottom of Well Screen 18 ft.*

Base of Borehole: 18 ft.*

Total Depth of Well Below Top of Casing: 20.43 ft.

*Indicates Depth Below Land Surface

BORING NO. WBSP-15-02
SAMPLE/CORE LOG

Project Number:	2015067	Log Page	1 of 1
Project Location:	Clifty Creek Plant West Boiler Slag Pond	Drilling Contractor:	Bowser Morner
Drilling Date(s):	11/11/15	AGES Geologist:	Mike Gelles

Drilling Method:	Roto-Sonic	Coring Device Size:	NA	Hammer Wt.	NA	and Drop	NA
Sampling Method:	NA	Borehole Diameter:	6”	Drilling Fluid Used:	Water		
Sampling Interval:	NA	Borehole Depth:	21’	Surface Elevation:	473.83’ MSL		

NOTES/COMMENTS:

Depth Interval (feet)	Sample Recovery (feet)	Penetration (Hyd. Pres. or Blow Counts)	Sample/Core Description	PID (PPM)
0-10	5	NA	Red brown silt, fine sand, black boiler slag, loose, moist	N/A
10-20	8	NA	10’-11’ Red brown silt, fine sand, black boiler slag, loose, moist; 11’-19’ light brown silty clay, stiff, moist; 19’-20’ light brown silty clay, stiff, rock fragments, moist	N/A
20-21	1	NA	Gray limestone	N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A

WELL CONSTRUCTION LOG
WELL NO. WBSP-15-02

Project Number: 2015067

Project Location: Clifty Creek Plant – West Boiler Slag Pond

Installation Date(s): 11/11/15

Drilling Method: Roto-Sonic

Drilling Contractor: Bowser Morner

Development Date(s): 12/7/15

Development Method: Submersible Pump, Peristaltic Pump, Bailer

Field parameters stabilized.

Turbidity = 3.69 NTUs

Volume Purged: 114.5 gallons

Static Water-Level* 15.40'

Top of Well Casing Elevation: 476.76'

Well Purpose:
Groundwater Monitoring

Northing (Y): 449803.91

Easting (X): 566987.30

Comments/Notes:
2 inch PVC riser and screen

5 ft of 0.010 pre-packed well screen with an inner filter pack of 0.40 mm clean quartz sand and an outer layer of food-grade nylon mesh.

Inspector: Michael Gelles

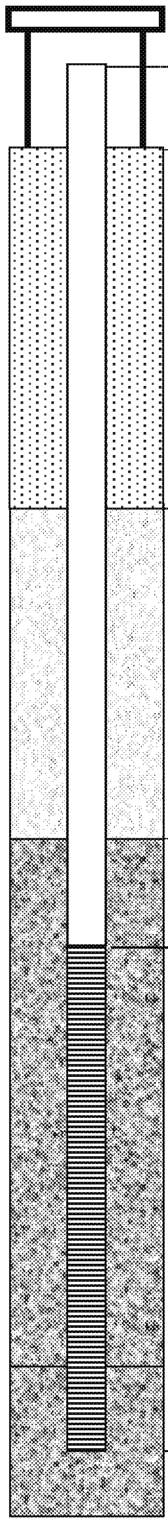
CONSTRUCTION MATERIALS USED:

3 Bags of Sand

4 Bags/Buckets Bentonite Pellets

___ Bags Portland for Grout

___ Bags Concrete/Sakrete



Protective Casing with Locking Cap

Top of Casing Elevation: 476.76 ft.

Stick-up: 2.93 ft.

Land Surface Elevation: 473.83 ft.

Grout; Type: Portland cement/Grout

Borehole Diameter: 6 inch

Casing Diameter: 2 Inch

Casing Material: PVC

Top of Seal: 2 ft*

Seal Type: Bentonite Pellets/Chips

Top of Sand/Gravel Pack: 14 ft*

Top of Well Screen 16 ft*

Sand/Gravel Pack; Type: Global #5

Screen Diameter: 2 Inch

Screen Slot-Size: 0.010 Inch

Screen Material: PVC

Bottom of Well Screen 21 ft.*

Base of Borehole: 21 ft.*

Total Depth of Well Below Top of Casing: 23.93 ft.

*Indicates Depth Below Land Surface

BORING NO. WBSP-15-03
SAMPLE/CORE LOG

Project Number:	2015067	Log Page	1 of 1
Project Location:	Clifty Creek Plant West Boiler Slag Pond	Drilling Contractor:	Bowser Morner
Drilling Date(s):	12/4/15	AGES Geologist:	Mike Gelles

Drilling Method:	Roto-Sonic	Coring Device Size:	NA	Hammer Wt.	NA	and Drop	NA
Sampling Method:	NA	Borehole Diameter:	6”	Drilling Fluid Used:	Water		
Sampling Interval:	NA	Borehole Depth:	18’	Surface Elevation:	484.91’ MSL		

NOTES/COMMENTS:

Depth Interval (feet)	Sample Recovery (feet)	Penetration (Hyd. Pres. or Blow Counts)	Sample/Core Description	PID (PPM)
0-10	2	NA	Brown silty clay, black boiler slag, limestone fragments, stiff, plastic, moist	N/A
10-18	8	NA	10’-13’ Brown silty clay, black boiler slag, limestone fragments, stiff, plastic, moist; 13’-18’ Gray, limestone, weathered, dry	N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A

WELL CONSTRUCTION LOG
WELL NO. WBSP-15-03

Project Number: 2015067

Project Location: Clifty Creek Plant – West Boiler Slag Pond

Installation Date(s): 12/4/15

Drilling Method: Roto-Sonic

Drilling Contractor: Bowser Morner

Development Date(s): 12/15/15

Development Method: Submersible Pump, Peristaltic Pump, Bailer

Field parameters stabilized.

Turbidity = 2.42 NTUs

Volume Purged: 14.5 gallons

Static Water-Level*: 11.08'

Top of Well Casing Elevation: 488.03'

Well Purpose:
Groundwater Monitoring

Northing (Y): 451181.98

Easting (X): 568093.60

Comments/Notes:
2 inch PVC riser and screen

5 ft of 0.010 pre-packed well screen with an inner filter pack of 0.40 mm clean quartz sand and an outer layer of food-grade nylon mesh.

Inspector: Michael Gelles

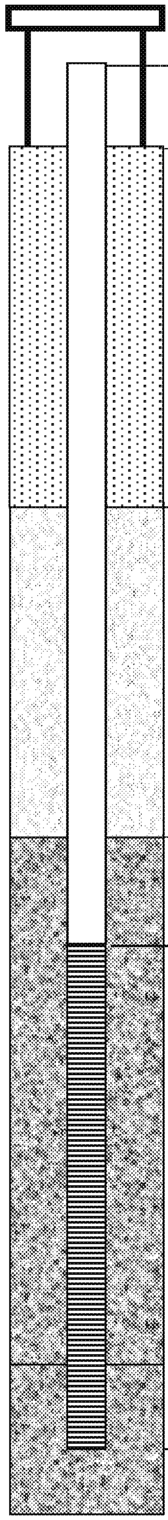
CONSTRUCTION MATERIALS USED:

3 Bags of Sand

4 Bags/Buckets Bentonite Pellets

____ Bags Portland for Grout

____ Bags Concrete/Sakrete



Protective Casing with Locking Cap

Top of Casing Elevation: 488.03 ft.

Stick-up: 3.12 ft.

Land Surface Elevation: 484.91 ft.

Grout; Type: Portland cement/Grout

Borehole Diameter: 6 inch

Casing Diameter: 2 Inch

Casing Material: PVC

Top of Seal: 2 ft*

Seal Type: Bentonite Pellets/Chips

Top of Sand/Gravel Pack: 6 ft*

Top of Well Screen 8 ft*

Sand/Gravel Pack; Type: Global #5

Screen Diameter: 2 Inch

Screen Slot-Size: 0.010 Inch

Screen Material: PVC

Bottom of Well Screen 13 ft.*

Base of Borehole: 18 ft.*

Total Depth of Well Below Top of Casing: 16.12 ft.

*Indicates Depth Below Land Surface

BORING NO. WBSP-15-04
SAMPLE/CORE LOG

Project Number:	2015067	Log Page	1 of 1
Project Location:	Clifty Creek Plant West Boiler Slag Pond	Drilling Contractor:	Bowser Morner
Drilling Date(s):	11/11/15-11/12/15	AGES Geologist:	Mike Gelles

Drilling Method:	Roto-Sonic	Coring Device Size:	NA	Hammer Wt.	NA	and Drop	NA
Sampling Method:	NA	Borehole Diameter:	6”	Drilling Fluid Used:	Water		
Sampling Interval:	NA	Borehole Depth:	70’	Surface Elevation:	471.17’ MSL		

NOTES/COMMENTS:

Depth Interval (feet)	Sample Recovery (feet)	Penetration (Hyd. Pres. or Blow Counts)	Sample/Core Description	PID (PPM)
0-10	8	NA	Red brown silt, fine sand, boiler slag, loose, moist	N/A
10-20	8	NA	Red brown silt, fine sand, boiler slag, loose, moist	N/A
20-30	8	NA	20’-28’ Red brown silt, fine sand, boiler slag, loose, moist; 28’-30’ wet	N/A
30-40	7	NA	Red brown silt, fine sand, boiler slag, loose, wet	N/A
40-50	10	NA	40’-45’ Red brown silt, fine sand, boiler slag, loose, wet; 45’-47’ Yellow brown clay, stiff, plastic, moist; 47’-49’ Yellow brown gravel angular, fine and medium sand, wet; 49’-50’ Orange brown sandy clay, fine, stiff, moist	N/A
50-60	9	NA	50’-53’ Orange brown sandy clay, fine, stiff, moist; 53’ – 60’ Light brown sand, fine, medium, coarse, gravel angular fine, medium, coarse, large, wet	N/A
60-70	7	NA	60’-68.5’ Light brown sand, fine, medium, coarse, gravel angular fine, medium, coarse, wet; 68.5’ -70’ light brown sand, fine, medium, coarse, black coal and peat, wet	N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A

WELL CONSTRUCTION LOG
WELL NO. WBSP-15-04

Project Number: 2015067

Project Location: Clifty Creek Plant – West Boiler Slag Pond

Installation Date(s): 11/11/15-11/12/15

Drilling Method: Roto-Sonic
Drilling Contractor: Bowser Morner

Development Date(s): 12/9/15

Development Method: Submersible Pump
Field parameters stabilized.
Turbidity = 0.91 NTUs

Volume Purged: 65 gallons

Static Water-Level* 50.68'

Top of Well Casing Elevation: 473.71'

Well Purpose:
Groundwater Monitoring
Northing (Y): 450610.07
Easting (X): 568637.65

Comments/Notes:
2 inch PVC riser and screen
10 ft of 0.010 pre-packed well screen with an inner filter pack of 0.40 mm clean quartz sand and an outer layer of food-grade nylon mesh.

Inspector: Michael Gelles

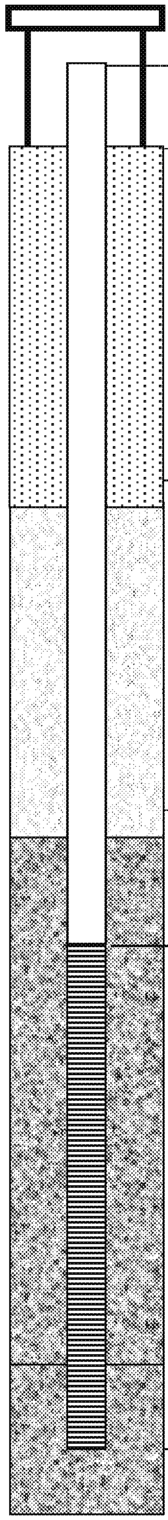
CONSTRUCTION MATERIALS USED:

5 Bags of Sand

2 Bags/Buckets Bentonite Pellets

12 Bags Portland for Grout

Bags Concrete/Sakrete



Protective Casing with Locking Cap

Top of Casing Elevation: 473.71 ft.
Stick-up: 2.54 ft.

Land Surface Elevation: 471.17 ft.

Grout; Type: Portland cement/ Grout

Borehole Diameter: 6 inch

Casing Diameter: 2 Inch
Casing Material: PVC
Top of Seal: 2 ft*

Seal Type: Bentonite Pellets/Chips

Top of Sand/Gravel Pack: 53 ft*

Top of Well Screen 55 ft*

Sand/Gravel Pack; Type: Global #5

Screen Diameter: 2 Inch
Screen Slot-Size: 0.010 Inch
Screen Material: PVC

Bottom of Well Screen 65 ft.*

Base of Borehole: 70 ft.*

Total Depth of Well
Below Top of Casing: 67.54 ft.

*Indicates Depth Below Land Surface

BORING NO. WBSP-15-05
SAMPLE/CORE LOG

Project Number:	2015067	Log Page	1 of 1
Project Location:	Clifty Creek Plant West Boiler Slag Pond	Drilling Contractor:	Bowser Morner
Drilling Date(s):	11/13/15-11/17/15	AGES Geologist:	John Campbell

Drilling Method:	Roto-Sonic	Coring Device Size:	NA	Hammer Wt.	NA	and Drop	NA
Sampling Method:	NA	Borehole Diameter:	6”	Drilling Fluid Used:	Water		
Sampling Interval:	NA	Borehole Depth:	71’	Surface Elevation:	471.90’ MSL		

NOTES/COMMENTS:

Depth Interval (feet)	Sample Recovery (feet)	Penetration (Hyd. Pres. or Blow Counts)	Sample/Core Description	PID (PPM)
0-10	8	NA	Red brown silt, fine sand, black boiler slag, loose, moist	N/A
10-20	8	NA	Red brown silt, fine sand, black boiler slag, loose, moist	N/A
20-30	6	NA	Red brown silt, fine sand, black boiler slag, loose, moist	N/A
30-40	5	NA	30’-33’ Red brown silt, fine sand, black boiler slag, loose, moist; 33’-35’ brown clay, wet, loose	N/A
40-50	8	NA	40’-45’ Brown clay(till), plastic, moist; 45’-50’ gray clay(till), plastic, moist	N/A
50-60	9	NA	50’-59’ Gray silty clay(till); sand fine, medium, coarse, and gravel subrounded fine, medium, coarse, large, little silt, very moist	N/A
60-70	5	NA	Gray to brown sand fine, medium, coarse, and gravel subrounded fine, medium, coarse, large, little silt, wet	N/A
70-71	1	NA	Gray to brown sand fine, medium, coarse, and gravel subrounded fine, medium, coarse, large, little silt, wet	N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A

WELL CONSTRUCTION LOG
WELL NO. WBSP-15-05

Project Number: 2015067

Project Location: Clifty Creek Plant – West Boiler Slag Pond

Installation Date(s): 11/13/15-11/17/15

Drilling Method: Roto-Sonic
Drilling Contractor: Bowser Morner

Development Date(s): 12/16/15

Development Method: Submersible Pump
Field parameters stabilized.
Turbidity = 4.28 NTUs

Volume Purged: 46 gallons

Static Water-Level* 52.42'

Top of Well Casing Elevation: 474.42'

Well Purpose:
Groundwater Monitoring
Northing (Y): 450051.40
Easting (X): 568495.72

Comments/Notes:
2 inch PVC riser and screen
10 ft of 0.010 pre-packed well screen with an inner filter pack of 0.40 mm clean quartz sand and an outer layer of food-grade nylon mesh.

Inspector: John Campbell

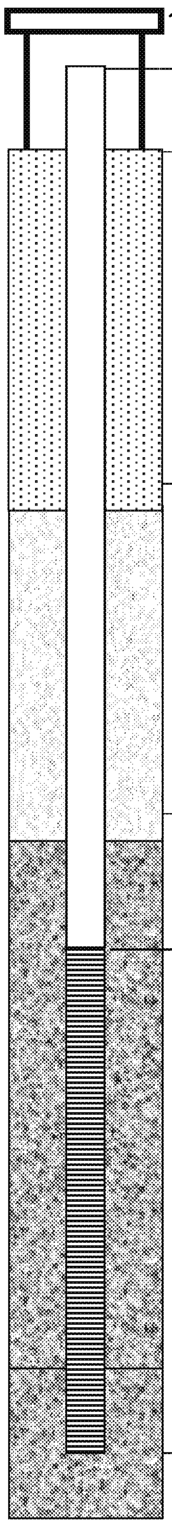
CONSTRUCTION MATERIALS USED:

6 Bags of Sand

2 Bags/Buckets Bentonite Pellets

18 Bags Portland for Grout

___ Bags Concrete/Sakrete



Protective Casing with Locking Cap

Top of Casing Elevation: 474.42 ft.
Stick-up: 2.52 ft.

Land Surface Elevation: 471.90 ft.

Grout; Type: Portland cement/ Grout

Borehole Diameter: 6 inch

Casing Diameter: 2 Inch
Casing Material: PVC
Top of Seal: 55 ft*

Seal Type: Bentonite Pellets/Chips

Top of Sand/Gravel Pack: 59 ft*

Top of Well Screen 61 ft*

Sand/Gravel Pack; Type: Global #5

Screen Diameter: 2 Inch
Screen Slot-Size: 0.010 Inch
Screen Material: PVC

Bottom of Well Screen 71 ft.*

Base of Borehole: 71 ft.*

Total Depth of Well
Below Top of Casing: 73.52 ft.

*Indicates Depth Below Land Surface

BORING NO. WBSP-15-06
SAMPLE/CORE LOG

Project Number:	2015067	Log Page	1 of 1
Project Location:	Clifty Creek Plant West Boiler Slag Pond	Drilling Contractor:	Bowser Morner
Drilling Date(s):	11/18/15-11/19/15	AGES Geologist:	John Campbell

Drilling Method:	Roto-Sonic	Coring Device Size:	NA	Hammer Wt.	NA	and Drop	NA
Sampling Method:	NA	Borehole Diameter:	6”	Drilling Fluid Used:	Water		
Sampling Interval:	NA	Borehole Depth:	90’	Surface Elevation:	471.28’ MSL		

NOTES/COMMENTS:

Depth Interval (feet)	Sample Recovery (feet)	Penetration (Hyd. Pres. or Blow Counts)	Sample/Core Description	PID (PPM)
0-10	7	NA	Black boiler slag and ash, loose, fill	N/A
10-20	7	NA	Black boiler slag and ash, loose, fill	N/A
20-30	6	NA	Black boiler slag and ash, loose, fill; 27’-30’ wet	N/A
30-40	6	NA	Black boiler slag and ash, loose, fill, 30’-34’ wet; 34’-36’ brown clay, some silt, hard, damp	N/A
40-50	10	NA	40’-48’ Gray silty clay, soft, very moist, moist 7’-8’; brown silty clay, firm, damp	N/A
50-60	10	NA	Gray silty clay, firm to soft, moist to very moist	N/A
60-70	10	NA	60’-65’ Gray silty clay, firm, moist to very moist; 65’ – 70’ Gray silt, clay, firm, wet	N/A
70-80	4	NA	70’ - 72’ Gray silty clay, firm, moist to very moist; 72’ – 74’ Gray silt, clay, firm, wet; 74’-76’ Gray to brown sand fine, medium, coarse, large and gravel subrounded fine, medium, coarse, large, wet	N/A
80-90	9	NA	80’-88’ Gray to brown sand fine, medium, coarse, large and gravel subrounded fine, medium, coarse, large, wet; 88’- 89’ Gray to brown sand fine, medium, coarse, large to sand fine, medium, wet	N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A

WELL CONSTRUCTION LOG
WELL NO. WBSP-15-06

Project Number: 2015067

Project Location: Clifty Creek Plant – West Boiler Slag Pond

Installation Date(s): 11/18/15-11/19/15

Drilling Method: Roto-Sonic
Drilling Contractor: Bowser Morner

Development Date(s): 12/9/15

Development Method: Submersible Pump
Field parameters stabilized.
Turbidity = 3.44 NTUs

Volume Purged: 100 gallons

Static Water-Level* 51.55'

Top of Well Casing Elevation: 473.51'

Well Purpose:
Groundwater Monitoring
Northing (Y): 449470.57
Easting (X): 568402.50

Comments/Notes:
2 inch PVC riser and screen
10 ft of 0.010 pre-packed well screen with an inner filter pack of 0.40 mm clean quartz sand and an outer layer of food-grade nylon mesh.

Inspector: John Campbell

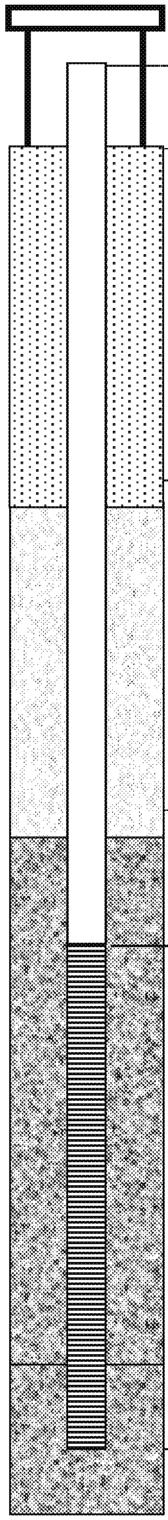
CONSTRUCTION MATERIALS USED:

6 Bags of Sand

2 Bags/Buckets Bentonite Pellets

12 Bags Portland for Grout

___ Bags Concrete/Sakrete



Protective Casing with Locking Cap

Top of Casing Elevation: 473.51 ft.
Stick-up: 2.23 ft.

Land Surface Elevation: 471.28 ft.

Grout; Type: Portland cement/ Grout

Borehole Diameter: 6 inch

Casing Diameter: 2 Inch
Casing Material: PVC
Top of Seal: 69.5 ft*

Seal Type: Bentonite Pellets/Chips

Top of Sand/Gravel Pack: 73.5 ft*

Top of Well Screen 75.5 ft*

Sand/Gravel Pack; Type: Global #5

Screen Diameter: 2 Inch
Screen Slot-Size: 0.010 Inch
Screen Material: PVC

Bottom of Well Screen 85.5 ft.*

Base of Borehole: 85.5 ft.*

Total Depth of Well Below Top of Casing: 87.73 ft.

*Indicates Depth Below Land Surface

BORING NO. WBSP-15-07
SAMPLE/CORE LOG

Project Number:	2015067	Log Page	1 of 1
Project Location:	Clifty Creek Plant West Boiler Slag Pond	Drilling Contractor:	Bowser Morner
Drilling Date(s):	11/20/15-11/23/15	AGES Geologist:	John Campbell

Drilling Method:	Roto-Sonic	Coring Device Size:	NA	Hammer Wt.	NA	and Drop	NA
Sampling Method:	NA	Borehole Diameter:	6”	Drilling Fluid Used:	Water		
Sampling Interval:	NA	Borehole Depth:	90’	Surface Elevation:	468.82’ MSL		

NOTES/COMMENTS:

Depth Interval (feet)	Sample Recovery (feet)	Penetration (Hyd. Pres. or Blow Counts)	Sample/Core Description	PID (PPM)
0-10	10	NA	Silty clay, some sand, some fine gravel, dense, hard, slightly moist. fill	N/A
10-20	8.5	NA	Brown silty clay, sand and gravel, gray 13’-14.5’, moist to very moist	N/A
20-30	10	NA	20’-28’ Brown with gray silty clay, moist; 28’-30’ brown silty clay, some gravel, trace sand, very moist to wet	N/A
30-40	10	NA	30’-34’ Gray silt, well compacted, damp; 34’-40’ brown silty clay, very hard, damp	N/A
40-50	10	NA	40’-48’ Gray silt, some very fine sand lenses, some clay; 48’-50’ gray silt, clay, moist	N/A
50-60	10	NA	50’-58’ Gray silt, clay, moist; 58’-60’ yellow brown silty clay, moist	N/A
60-70	10	NA	60’-64’ Gray silt, some sand lenses, some clay; 64’-70’ gray silty clay, some roots and organic matter, firm	N/A
70-80	9	NA	70’-78’ Gray silty clay, some roots and organic matter, firm; 78’-80’ Gray silt, some sand lenses, some clay, wet	N/A
80-90	9	NA	80’-83’ Gray sandy silty, clay, wet; 83’-86’ gray silty clay, hard, moist; 86’-90’ gray sand, silt, wood, wet	N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A

WELL CONSTRUCTION LOG
WELL NO. WBSP-15-07

Project Number: 2015067

Project Location: Clifty Creek Plant – West Boiler Slag Pond

Installation Date(s): 11/20/15-11/23/15

Drilling Method: Roto-Sonic
Drilling Contractor: Bowser Morner

Development Date(s): 12/16/15

Development Method: Submersible Pump
Field parameters stabilized.
Turbidity = 2.86 NTUs

Volume Purged: 35.5 gallons

Static Water-Level* 41.01'

Top of Well Casing Elevation: 471.31'

Well Purpose:
Groundwater Monitoring
Northing (Y): 448947.93
Easting (X): 567946.39

Comments/Notes:
2 inch PVC riser and screen
10 ft of 0.010 pre-packed well screen with an inner filter pack of 0.40 mm clean quartz sand and an outer layer of food-grade nylon mesh.

Inspector: John Campbell

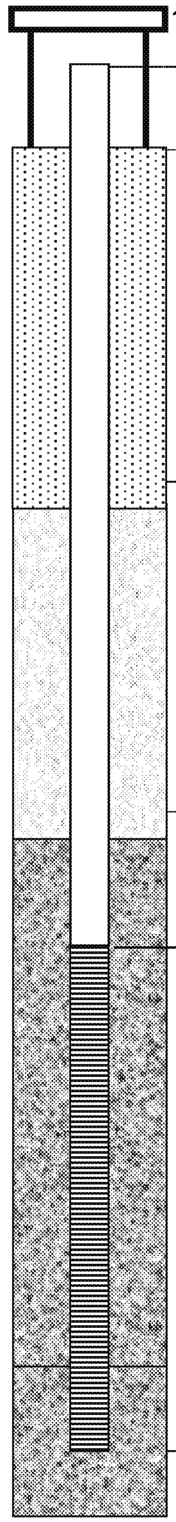
CONSTRUCTION MATERIALS USED:

6 Bags of Sand

14 Bags/Buckets Bentonite Pellets

12 Bags Portland for Grout

_____ Bags Concrete/Sakrete



Protective Casing with Locking Cap

Top of Casing Elevation: 471.31 ft.
Stick-up: 2.49 ft.

Land Surface Elevation: 468.82 ft.

Grout; Type: Portland cement/ Grout

Borehole Diameter: 6 inch

Casing Diameter: 2 Inch
Casing Material: PVC
Top of Seal: 36 ft*

Seal Type: Bentonite Pellets/Chips

Top of Sand/Gravel Pack: 40 ft*

Top of Well Screen 42 ft*

Sand/Gravel Pack; Type: Global #5

Screen Diameter: 2 Inch
Screen Slot-Size: 0.010 Inch
Screen Material: PVC

Bottom of Well Screen 52 ft.*

Base of Borehole: 90 ft.*

Total Depth of Well Below Top of Casing: 54.49 ft.

*Indicates Depth Below Land Surface

BORING NO. WBSP-15-08
SAMPLE/CORE LOG

Project Number:	2015067	Log Page	1 of 1
Project Location:	Clifty Creek Plant West Boiler Slag Pond	Drilling Contractor:	Bowser Morner
Drilling Date(s):	11/24/15-11/25/15	AGES Geologist:	John Campbell

Drilling Method:	Roto-Sonic	Coring Device Size:	NA	Hammer Wt.	NA	and Drop	NA
Sampling Method:	NA	Borehole Diameter:	6”	Drilling Fluid Used:	Water		
Sampling Interval:	NA	Borehole Depth:	80’	Surface Elevation:	468.56’ MSL		

NOTES/COMMENTS:

Depth Interval (feet)	Sample Recovery (feet)	Penetration (Hyd. Pres. or Blow Counts)	Sample/Core Description	PID (PPM)
0-10	8	NA	Brown silty clay, some sand and gravel, damp, fill	N/A
10-20	9	NA	Brown silty clay, firm, damp to moist	N/A
20-30	7	NA	Brown silty clay, firm, moist	N/A
30-40	10	NA	30’-37’ Brown silty clay, firm, moist; 37’-40’ gray clay, stiff, slightly plastic, very moist	N/A
40-50	9	NA	40’-44.5’ Gray clay, stiff, slightly plastic, very moist; 44.5’-50’ Gray silt, clay, some very fine sand, wet	N/A
50-60	10	NA	50’-59’ Gray silt, clay, some very fine sand, wet; 59’-60’ gray silty clay, moist	N/A
60-70	8.5	NA	Gray silty and silty clay lenses intermittent, wet	N/A
70-80	9	NA	70’-76’ Gray silty and silty clay lenses intermittent, wet; 76’-79’ gray silty clay, firm, moist	N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A

WELL CONSTRUCTION LOG
WELL NO. WBSP-15-08

Project Number: 2015067

Project Location: Clifty Creek Plant – West Boiler Slag Pond

Installation Date(s): 11/24/15-11/25/15

Drilling Method: Roto-Sonic
Drilling Contractor: Bowser Morner

Development Date(s): 12/16/15

Development Method: Submersible Pump
Field parameters stabilized.
Turbidity = 4.96 NTUs

Volume Purged: 89.5 gallons

Static Water-Level* 37.02'

Top of Well Casing Elevation: 471.06'

Well Purpose:
Groundwater Monitoring
Northing (Y): 448625.46
Easting (X): 567343.24

Comments/Notes:
2 inch PVC riser and screen
10 ft of 0.010 pre-packed well screen with an inner filter pack of 0.40 mm clean quartz sand and an outer layer of food-grade nylon mesh.

Inspector: John Campbell

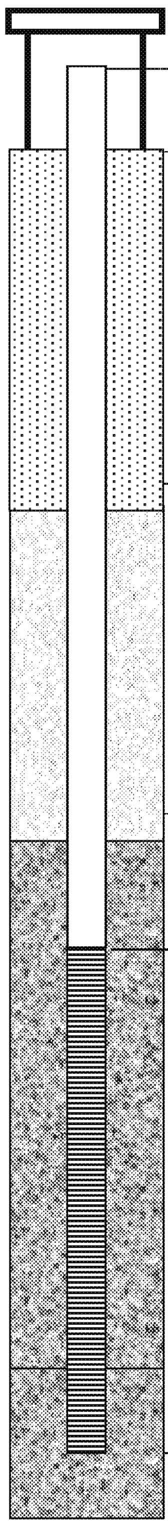
CONSTRUCTION MATERIALS USED:

8 Bags of Sand

4 Bags/Buckets Bentonite Pellets

12 Bags Portland for Grout

Bags Concrete/Sakrete



Protective Casing with Locking Cap

Top of Casing Elevation: 471.06 ft.
Stick-up: 2.5 ft.

Land Surface Elevation: 468.56 ft.

Grout; Type: Portland cement/ Grout

Borehole Diameter: 6 inch

Casing Diameter: 2 Inch
Casing Material: PVC
Top of Seal: 46.5 ft*

Seal Type: Bentonite Pellets/Chips

Top of Sand/Gravel Pack: 50.5 ft*

Top of Well Screen 52.8 ft*

Sand/Gravel Pack; Type: Global #5

Screen Diameter: 2 Inch
Screen Slot-Size: 0.010 Inch
Screen Material: PVC

Bottom of Well Screen 62.8 ft.*

Base of Borehole: 80 ft.*

Total Depth of Well Below Top of Casing: 65.3 ft.

*Indicates Depth Below Land Surface

BORING NO. WBSP-15-09
SAMPLE/CORE LOG

Project Number:	2015067	Log Page	1 of 1
Project Location:	Clifty Creek Plant West Boiler Slag Pond	Drilling Contractor:	Bowser Morner
Drilling Date(s):	1/5/16-1/6/16	AGES Geologist:	Mike Gelles

Drilling Method:	HSA	Coring Device Size:	NA	Hammer Wt.	160lb. and Drop 2ft
Sampling Method:	NA	Borehole Diameter:	4.25”	Drilling Fluid Used:	Water
Sampling Interval:	NA	Borehole Depth:	60’	Surface Elevation:	471.21’ MSL

NOTES/COMMENTS:

Depth Interval (feet)	Sample Recovery (feet)	Penetration (Hyd. Pres. or Blow Counts)	Sample/Core Description	PID (PPM)
0-30			Advance augers – no samples	N/A
30-32	1	4-5-7-8	Orange brown silty clay, trace fine sand, stiff, moist	N/A
32-34	1.2	3-6-8-9	Orange brown silty clay, trace fine sand, stiff, moist	N/A
34-36	1.8	3-5-8-7	Orange brown silty clay, trace fine sand, stiff, moist	N/A
36-38	1	2-3-5-7	Orange brown silty clay, trace fine sand, stiff, moist	N/A
38-40	1.6	2-3-4-6	Orange brown silty clay, trace fine sand, stiff, moist	N/A
40-42	1.5	3-3-5-6	Orange brown silty clay, trace fine sand, stiff, moist; to gray last 8”	N/A
42-44	2	3-5-7-8	42’-43’ Orange brown silty clay, trace fine sand, stiff, moist; 43’-44’ Gray silty clay, stiff, moist	N/A
44-46	2	3-4-4-4	44’-44.5’ Gray silty clay, stiff, moist; 44.5’-46’ gray silty fine sand, moist	N/A
46-48	2	1-2-2-3	46’-46.5’ Gray silty fine sand, moist; 46.5’-48’ gray silty clay, fine sand, stiff, plastic, moist	N/A
48-50	2	3-4-4-4	48’-49’ Gray silty clay, fine sand, stiff, plastic, moist; 49’-50’ Orange brown sandy clay fine, stiff, wet	N/A
50-52	2	2-4-4-4	Gray brown sandy silt, fine sand seams, wet	N/A
52-54	2	2-2-3-5	Orange brown sandy silt, fine sand seams, wet	N/A
54-56	2	3-4-5-6	Gray brown sandy silt, fine sand seams, wet	N/A
56-58	2	2-2-2-2	Gray brown sandy silt, fine sand seams, wet	N/A
58-60	2	2-2-3-3	Gray brown sandy silt, fine sand seams, wet	N/A
				N/A

WELL CONSTRUCTION LOG
WELL NO. WBSP-15-09

Project Number: 2015067

Project Location: Clifty Creek Plant – West Boiler Slag Pond

Installation Date(s): 1/5/16-1/6/16

Drilling Method: Hollow Stem Auger
Drilling Contractor: Bowser Morner

Development Date(s): 1/19/16

Development Method: Submersible Pump
Field parameters stabilized.
Turbidity = 3.57 NTUs

Volume Purged: 74.5 gallons

Static Water-Level* 38.52'

Top of Well Casing Elevation: 470.69'

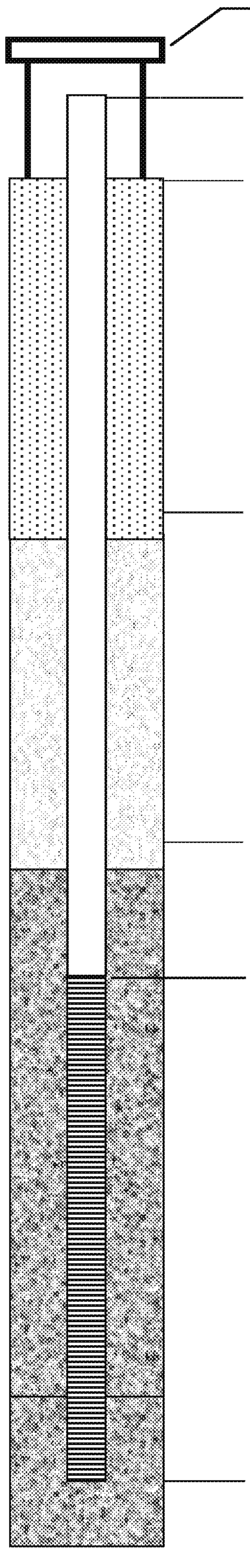
Well Purpose:
Groundwater Monitoring
Northing (Y): 448359.31
Easting (X): 566711.13

Comments/Notes:
2 inch PVC riser and screen
10 ft of 0.010 pre-packed well screen with an inner filter pack of 0.40 mm clean quartz sand and an outer layer of food-grade nylon mesh.

Inspector: Michael Gelles

CONSTRUCTION MATERIALS USED:

7	Bags of Sand
2	Bags/Buckets Bentonite Pellets
10	Bags Portland for Grout
	Bags Concrete/Sakrete



Protective Casing with Locking Cap

Top of Casing Elevation: 470.69 ft.
Stick-up: -0.52 ft.

Land Surface Elevation: 471.21 ft.

Grout; Type: Portland cement/ Grout

Borehole Diameter: 4.25 inch

Casing Diameter: 2 Inch
Casing Material: PVC
Top of Seal: 44 ft*

Seal Type: Bentonite Pellets/Chips

Top of Sand/Gravel Pack: 48 ft*

Top of Well Screen 50 ft*

Sand/Gravel Pack; Type: Global #5

Screen Diameter: 2 Inch
Screen Slot-Size: 0.010 Inch
Screen Material: PVC

Bottom of Well Screen 60 ft.*

Base of Borehole: 60 ft.*

Total Depth of Well Below Top of Casing: 59.48 ft.

*Indicates Depth Below Land Surface

BORING NO. WBSP-15-10
SAMPLE/CORE LOG

Project Number:	2015067	Log Page	1 of 1
Project Location:	Clifty Creek Plant West Boiler Slag Pond	Drilling Contractor:	Bowser Morner
Drilling Date(s):	1/4/16-1/5/16	AGES Geologist:	Mike Gelles

Drilling Method:	HSA	Coring Device Size:	NA	Hammer Wt.	160lb. and Drop 2ft
Sampling Method:	NA	Borehole Diameter:	4.25"	Drilling Fluid Used:	Water
Sampling Interval:	NA	Borehole Depth:	56'	Surface Elevation:	471.21' MSL

NOTES/COMMENTS:

Depth Interval (feet)	Sample Recovery (feet)	Penetration (Hyd. Pres. or Blow Counts)	Sample/Core Description	PID (PPM)
0-30			Advance augers – no samples	N/A
30-32	1.5	4-8-10-11	Orange brown silty clay, trace fine sand, stiff, moist	N/A
32-34	2	4-7-9-12	Orange brown silty clay, trace fine sand, stiff, moist	N/A
34-36	1.5	4-8-10-10	Orange brown silty clay, trace fine sand, stiff, moist	N/A
36-38	1.6	4-4-5-7	36'-37' Orange brown silty clay, trace fine sand, stiff, moist; 37'-38' brown gray sandy silt, moist	N/A
38-40	2	3-3-4-4	Brown gray silty clay, stiff, moist	N/A
40-42	2	2-2-3-3	Brown gray silty clay, stiff, moist	N/A
42-44	2	2-2-3-3	Orange brown sandy clay, stiff, plastic, moist	N/A
44-46	2	1-1-2-1	Orange brown sandy clay, stiff, plastic, moist; with 3"-4" fine and medium sand seams, wet	N/A
46-48	2	1-1-1-2	Brown gray sandy clay, stiff, plastic, moist; fine and medium sand seams, wet	N/A
48-50	1	1-2-2-3	Brown gray silty clay, fine sand, wet	N/A
50-52	1.6	2-2-3-4	Brown gray silty clay, fine sand, wet	N/A
52-54	1	1-2-2-3	Brown gray silty clay, fine sand, wet	N/A
54-56	2	1-2-2-2	Brown gray silty clay, fine sand, wet	N/A
				N/A
				N/A
				N/A

WELL CONSTRUCTION LOG
WELL NO. WBSP-15-10

Project Number: 2015067

Project Location: Clifty Creek Plant – West Boiler Slag Pond

Installation Date(s): 1/4/16-1/5/16

Drilling Method: Hollow Stem Auger
Drilling Contractor: Bowser Morner

Development Date(s): 1/20/16

Development Method: Submersible Pump
Field parameters stabilized.
Turbidity = 3.59 NTUs

Volume Purged: 58.5 gallons

Static Water-Level* 39.28'

Top of Well Casing Elevation: 470.69'

Well Purpose:
Groundwater Monitoring
Northing (Y): 448125.51
Easting (X): 566225.21

Comments/Notes:
2 inch PVC riser and screen
10 ft of 0.010 pre-packed well screen with an inner filter pack of 0.40 mm clean quartz sand and an outer layer of food-grade nylon mesh.

Inspector: Michael Gelles

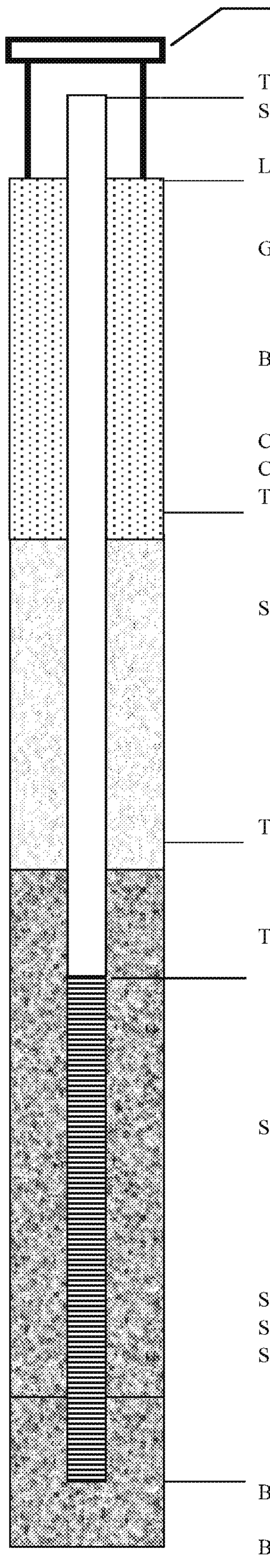
CONSTRUCTION MATERIALS USED:

8.5 Bags of Sand

2 Bags/Buckets Bentonite Pellets

10 Bags Portland for Grout

____ Bags Concrete/Sakrete



Protective Casing with Locking Cap

Top of Casing Elevation: 470.69 ft.
Stick-up: -0.52 ft.

Land Surface Elevation: 471.21 ft.

Grout; Type: Portland cement/ Grout

Borehole Diameter: 4.25 inch

Casing Diameter: 2 Inch
Casing Material: PVC
Top of Seal: 40 ft*

Seal Type: Bentonite Pellets/Chips

Top of Sand/Gravel Pack: 44 ft*

Top of Well Screen 46 ft*

Sand/Gravel Pack; Type: Global #5

Screen Diameter: 2 Inch
Screen Slot-Size: 0.010 Inch
Screen Material: PVC

Bottom of Well Screen 56 ft.*

Base of Borehole: 56 ft.*

Total Depth of Well
Below Top of Casing: 55.48 ft.

*Indicates Depth Below Land Surface

APPENDIX C

WELL DEVELOPMENT DATA

TABLE C-1
SUMMARY OF WELL DEVELOPMENT DATA
KYGER CREEK PLANT
GALLIA COUNTY, OHIO

Well/ Piezometer	Dates	Method	Volume (gal)	Final Turbidity (NTU)
Type I Residual Waste Landfill and Landfill Runoff Collection Pond				
CF-15-04	12/9/2015	Pump	65	0.91
CF-15-05	12/09/2015 - 12/16/2015	Pump	46	4.28
CF-15-06	12/09/2015 - 12/18/2016	Pump/Bail	21	9.59
CF-15-07	12/08/2015 - 12/15/2015	Pump/Bail	13	4.42
CF-15-08	12/8/2015	Pump	100	2.16
CF-15-09	12/08/2015 - 12/16/2015	Pump/Bail	6	3.21
West Boiler Slag Pond				
WBSP-15-01	12/03/2015 - 12/17/2015	Pump/Bail	23	70.8
WBSP-15-02	12/03/2015 - 12/15/2015	Pump	31.5	3.48
WBSP-15-03	12/09/2015 - 12/15/2015	Pump/Bail	15	2.42
WBSP-15-04	12/02/2015 - 12/08/2015	Pump	110	1.37
WBSP-15-05	12/02/2015 - 12/03/2015	Pump	130	1.87
WBSP-15-06	12/03/2015 - 12/09/2015	Pump	100	3.44
WBSP-15-07	12/02/2015 -12/16/2015	Pump/Bail	36	2.86
WBSP-15-08	12/02/2015 - 12/16/2015	Pump	90	4.96
WBSP-15-09	1/08/2016 - 1/19/2016	Pump	59	3.57
WBSP-15-10	1/07/2016 - 1/20/2016	Pump	33	3.59

APPENDIX D

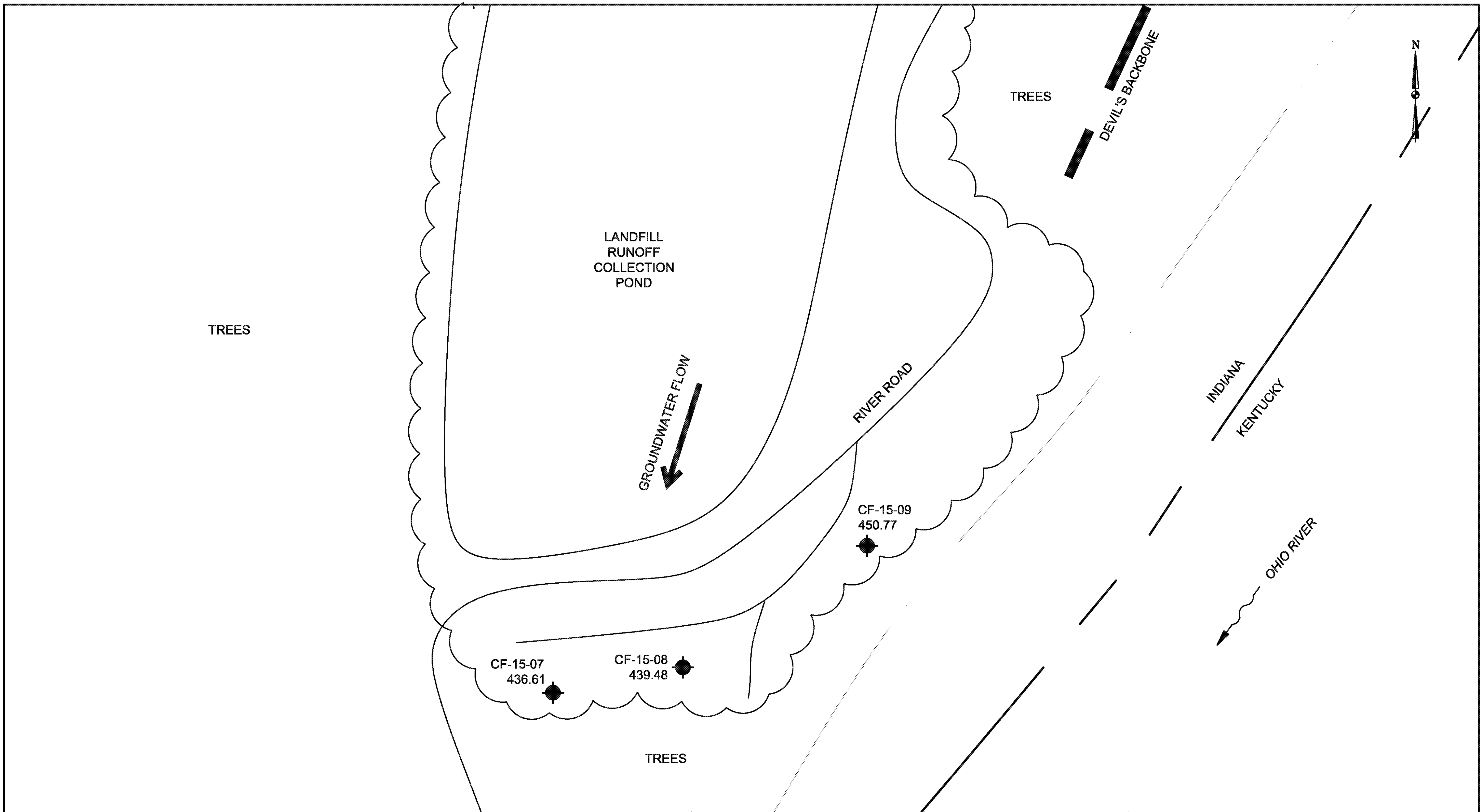
GROUNDWATER LEVELS
January 2016 through May 2016

TABLE D-1
CLIFTY CREEK CREEK PLANT
SUMMARY OF GROUNDWATER ELEVATION DATA
JANUARY 2016 - MAY 2016

Monitoring Well Designation	Jan-16 Groundwater Elevation (ft)	Mar-16 Groundwater Elevation (ft)	May-16 Groundwater Elevation (ft)
LANDFILL AND LANDFILL RUNOFF COLLECTION POND			
CF-15-04	439.83	441.19	441.27
CF-15-05	438.68	439.86	436.25
CF-15-06	432.27	437.12	429.22
CF-15-07	436.61	438.08	437.48
CF-15-08	439.48	440.54	440.88
CF-15-09	450.77	451.58	450.69
WEST BOILER SLAG POND			
WBSP-15-01	451.72	453.01	453.27
WBSP-15-02	468.31	472.52	471.52
WBSP-15-03	477.03	477.11	477.62
WBSP-15-04	429.22	436.25	424.96
WBSP-15-05	428.95	436.12	424.84
WBSP-15-06	428.82	436.06	424.77
WBSP-15-07	429.72	430.41	430.88
WBSP-15-08	434.03	434.62	434.81
WBSP-15-09	432.17	430.39	432.21
WBSP-15-10	431.41	433.28	432.58

APPENDIX E

GROUNDWATER CONTOUR MAPS
January 2016 through May 2016



LEGEND:

- MONITORING WELL LOCATION
- GROUNDWATER FLOW DIRECTION

200' 0' 200' 400'

SCALE: 1"= 200'

DRAWN BY	JM
DATE	
CHECKED BY	
JOB NO.	2015067-CLI
DWG FILE	IKEC_Clifty MW Install_Appx E_Jan16 b08.dwg
DRAWING SCALE	AS SHOWN

AGES
Applied Geology And Environmental Science, Inc.
2402 Hookstown Grade Road, Suite 200
Clinton, PA 15026
412.264.6453

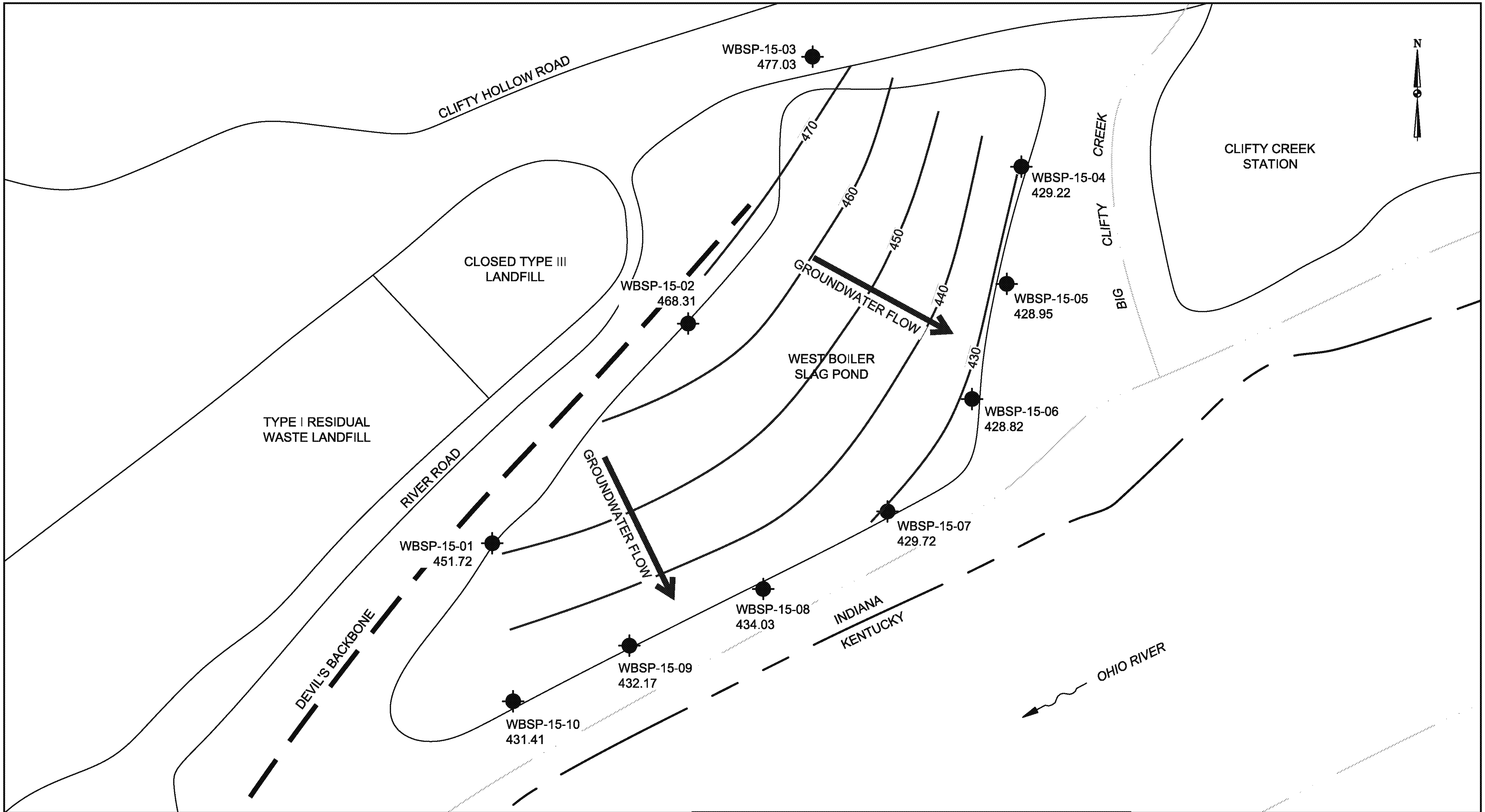
INDIANA–KENTUCKY ELECTRIC CORPORATION

CLIFTY CREEK STATION
MADISON, INDIANA
TYPE I RESIDUAL WASTE LANDFILL AND
LANDFILL RUNOFF COLLECTION POND
GROUNDWATER LEVELS & FLOW DIRECTION–JANUARY 2016

DRAWING NAME: FIGURE E–1

REV. 0

Plot: 10/04/2018 10:27 _PROGRAMS–IKEC\Clifty Creek–CCR Program\CAD\Clifty CCR MW Install\Appendix E\IKEC_Clifty MW Install_Appx E_Jan16 b08.dwg\E–1



LEGEND:

- MONITORING WELL LOCATION
- GROUNDWATER FLOW DIRECTION

400' 0' 400' 800'

SCALE: 1"= 400'

DRAWN BY	JM
DATE	
CHECKED BY	
JOB NO.	2015067–CLI
DWG FILE	IKEC_Clifty MW Install_Appx E_Jan16 b08.dwg
DRAWING SCALE	AS SHOWN

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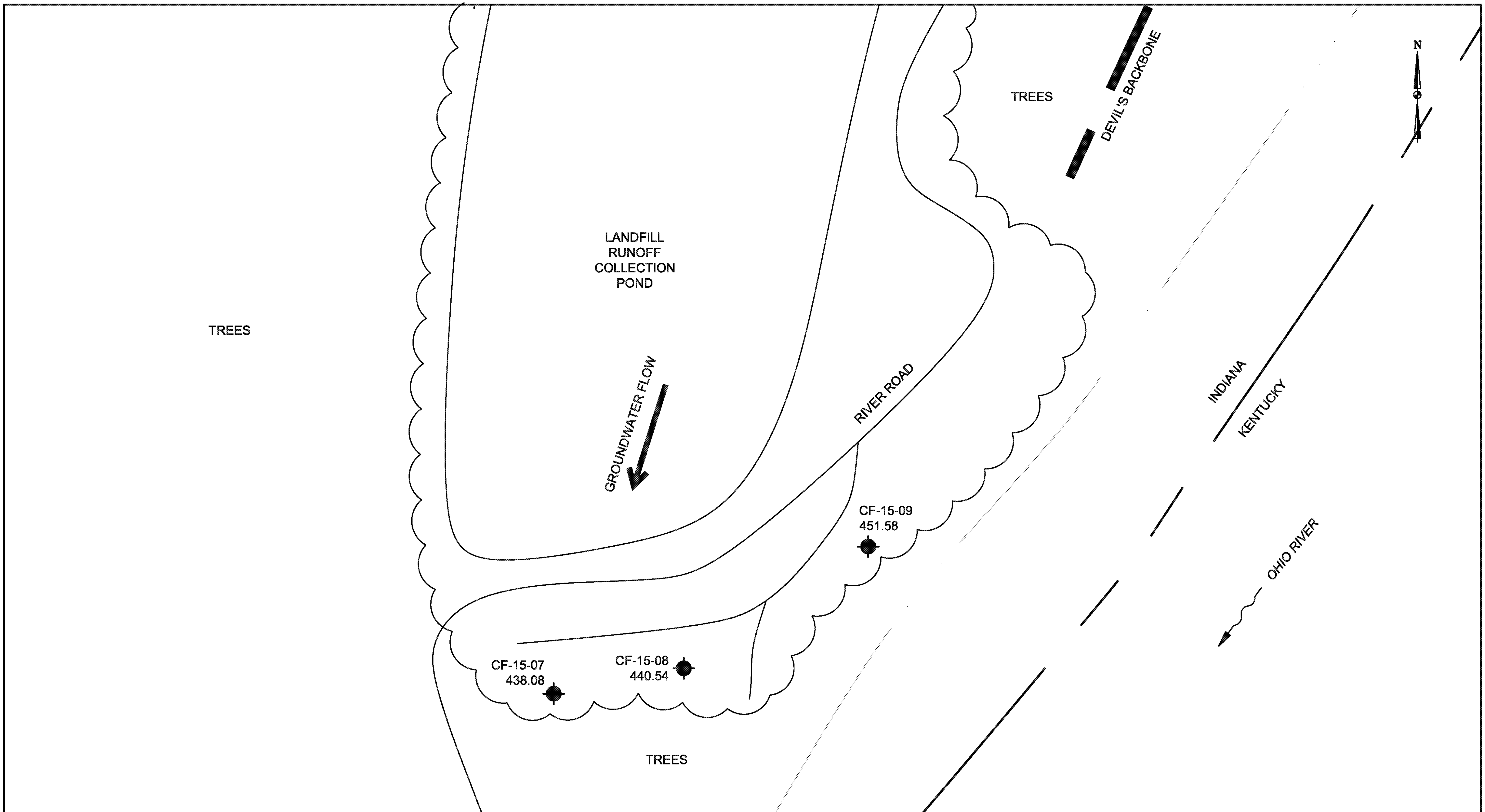
INDIANA–KENTUCKY ELECTRIC CORPORATION

CLIFTY CREEK STATION
MADISON, INDIANA
WEST BOILER SLAG POND
GROUNDWATER LEVELS & FLOW DIRECTION–JANUARY 2016

DRAWING NAME: FIGURE E–2

REV. 0

Plot: 10/02/2018 11:32 _PROGRAMS–IKEC\Clifty Creek–CCR Program\CAD\Clifty CCR MW Install\Appendix E\IKEC_Clifty MW Install_Appx E_Jan16 b08.dwg\E–2



LEGEND:

- MONITORING WELL LOCATION
- GROUNDWATER FLOW DIRECTION

200' 0' 200' 400'

SCALE: 1"= 200'

DRAWN BY	JM
DATE	
CHECKED BY	
JOB NO.	2015067-CLI
DWG. FILE	IKEC_Clifty MW Install_Appx E_Mar16 b09.dwg
DRAWING SCALE	AS SHOWN

AGES
Applied Geology And Environmental Science, Inc.
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Clinton, PA 15026
412.264.6453

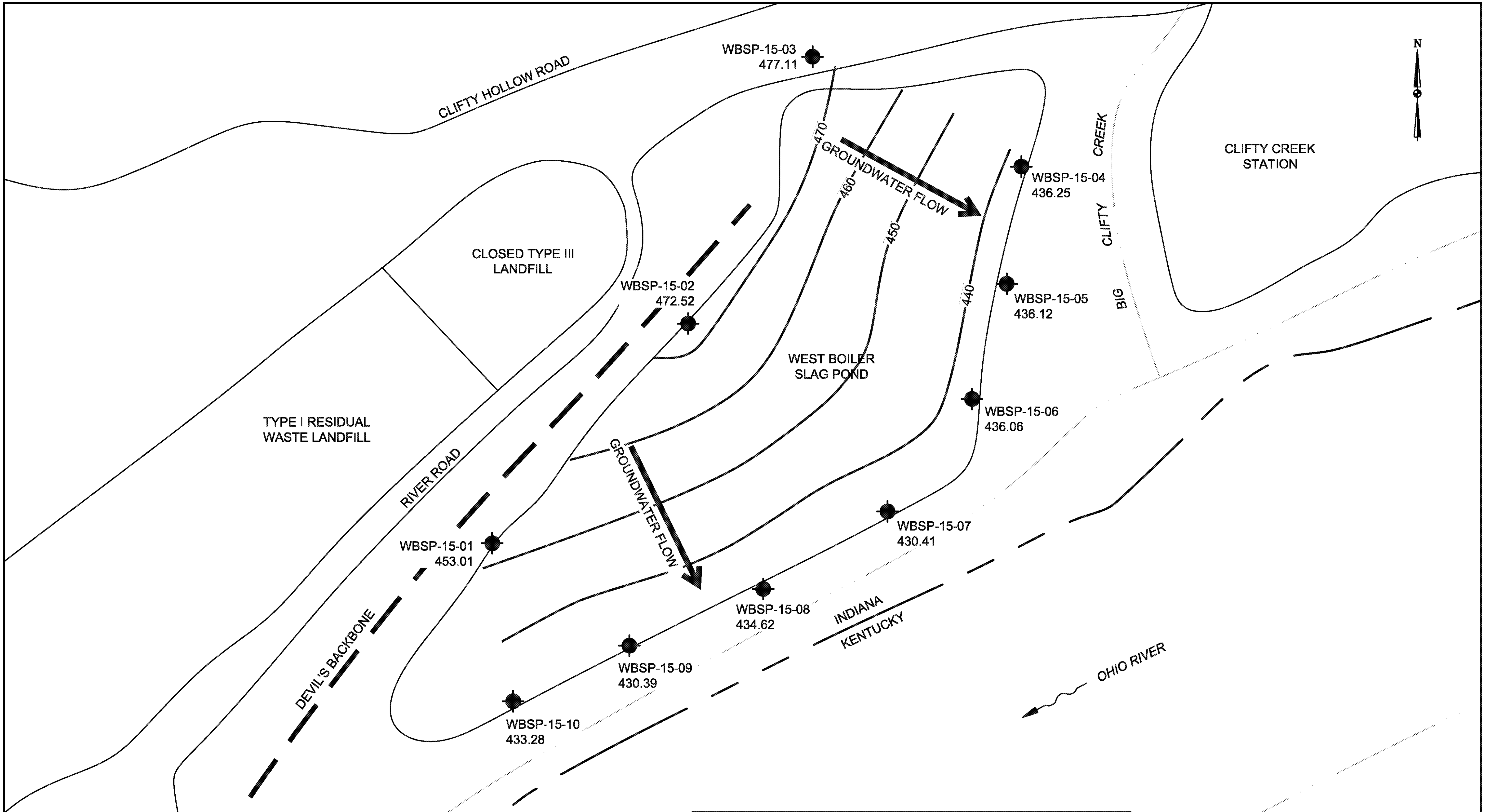
INDIANA–KENTUCKY ELECTRIC CORPORATION

CLIFTY CREEK STATION
MADISON, INDIANA
TYPE I RESIDUAL WASTE LANDFILL AND
LANDFILL RUNOFF COLLECTION POND
GROUNDWATER LEVELS & FLOW DIRECTION–MARCH 2016

DRAWING NAME: FIGURE E–3

REV. 0

Plot: 10/04/2018 10:29 _PROGRAMS–IKEC\Clifty Creek–CCR Program\CAD\Clifty CCR MW Install\Appendix E\IKEC_Clifty MW Install_Appx E_Mar16 b09.dwg\E–3



LEGEND:

- MONITORING WELL LOCATION
- GROUNDWATER FLOW DIRECTION

400' 0' 400' 800'

SCALE: 1"= 400'

DRAWN BY	JM
DATE	
CHECKED BY	
JOB NO.	2015067–CLI
DWG. FILE	IKEC_Clifty MW Install_Appx E_Mar16 b09.dwg
DRAWING SCALE	AS SHOWN

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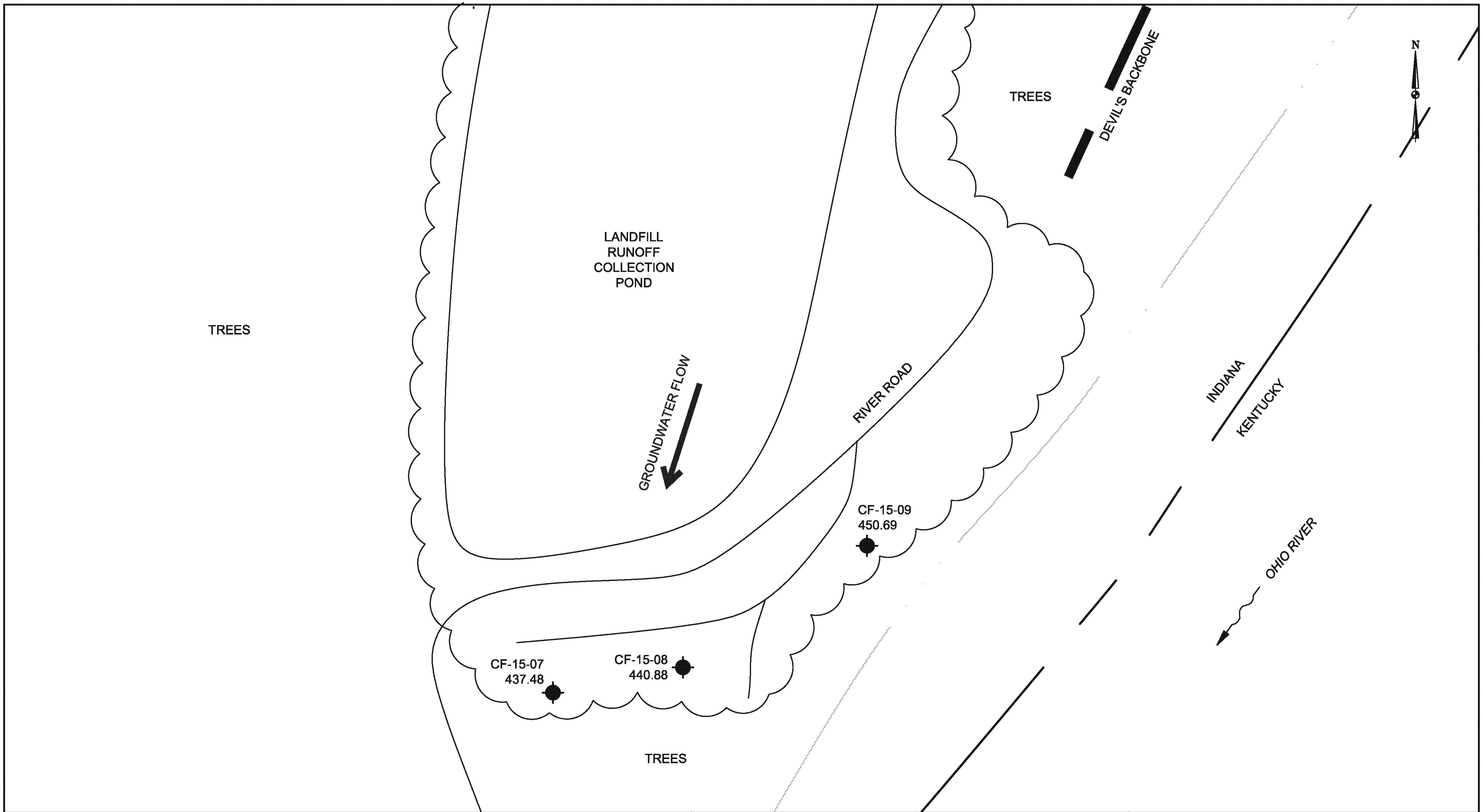
INDIANA–KENTUCKY ELECTRIC CORPORATION

CLIFTY CREEK STATION
MADISON, INDIANA
WEST BOILER SLAG POND
GROUNDWATER LEVELS & FLOW DIRECTION–MARCH 2016

DRAWING NAME: FIGURE E–4

REV. 0

Plot: 10/02/2018 11:45 _PROGRAMS–IKEC\Clifty Creek–CCR Program\CAD\Clifty CCR MW Install\Appendix E\IKEC_Clifty MW Install_Appx E_Mar16 b09.dwg\E–4



LEGEND:

- MONITORING WELL LOCATION
- GROUNDWATER FLOW DIRECTION

200' 0' 200' 400'

SCALE: 1"= 200'

DRAWN BY	JM
DATE	
CHECKED BY	
JOB NO.	2015067–CLI
DWG. FILE	IKEC_Clifty MW Install_Appx E_May16 b10.dwg
DRAWING SCALE	AS SHOWN

AGES
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Clinton, PA 15026
412.264.6453

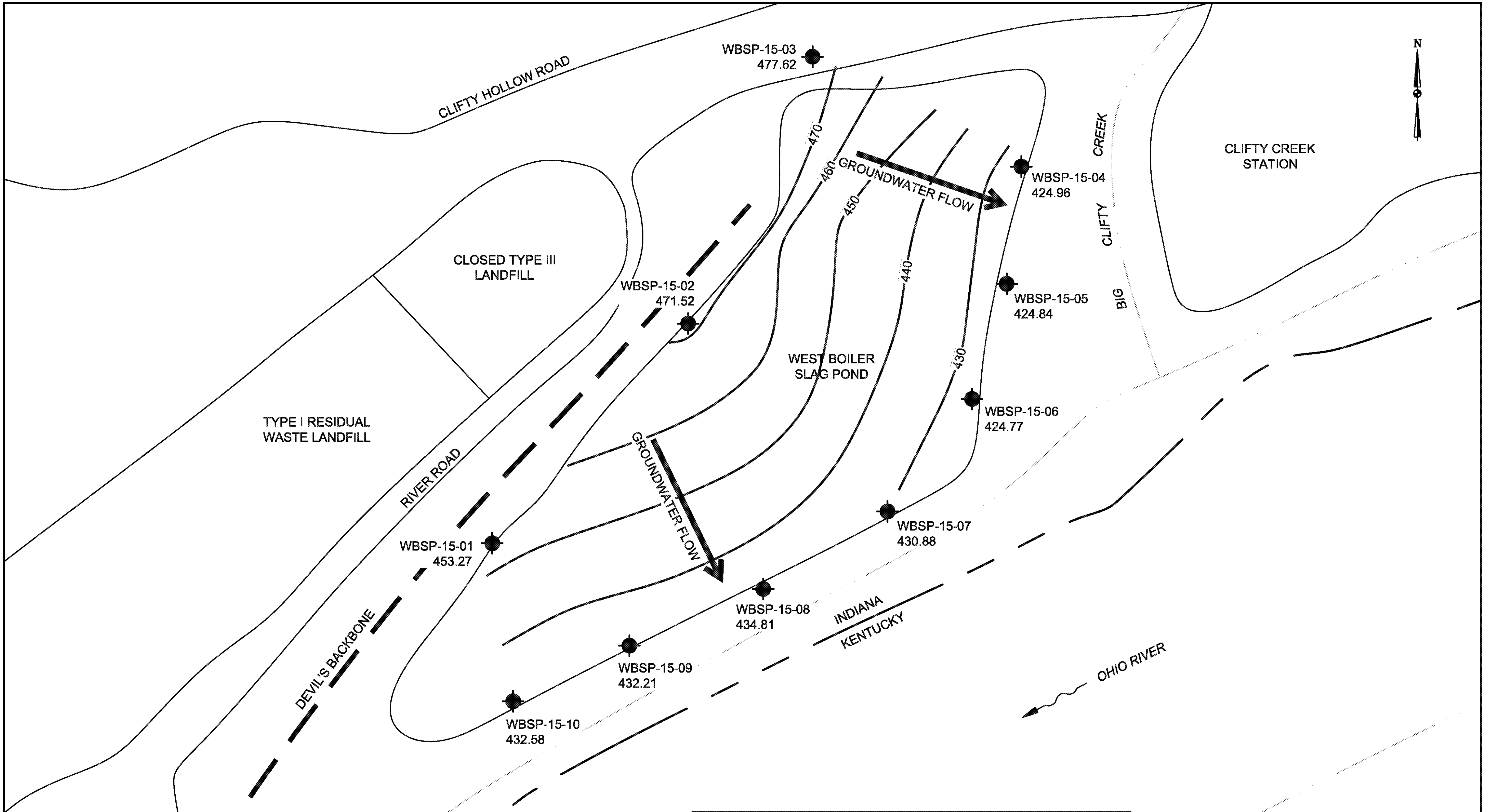
INDIANA–KENTUCKY ELECTRIC CORPORATION

CLIFTY CREEK STATION
MADISON, INDIANA
TYPE I RESIDUAL WASTE LANDFILL AND
LANDFILL RUNOFF COLLECTION POND
GROUNDWATER LEVELS & FLOW DIRECTION–MAY 2016

DRAWING NAME: FIGURE E–5

REV. 0

Plot: 10/04/2018 10:31 _PROGRAMS–IKEC\Clifty Creek–CCR Program\CAD\Clifty CCR MW Install\Appendix E\IKEC_Clifty MW Install_Appx E_May16 b10.dwg\E–5



LEGEND:

- MONITORING WELL LOCATION
- GROUNDWATER FLOW DIRECTION

400' 0' 400' 800'

SCALE: 1"= 400'

DRAWN BY	JM
DATE	
CHECKED BY	
JOB NO.	2015067-CLI
DWG FILE	IKEC_Clifty MW Install_Appx E_May16 b10.dwg
DRAWING SCALE	AS SHOWN

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INDIANA–KENTUCKY ELECTRIC CORPORATION

CLIFTY CREEK STATION
MADISON, INDIANA
WEST BOILER SLAG POND
GROUNDWATER LEVELS & FLOW DIRECTION–MAY 2016

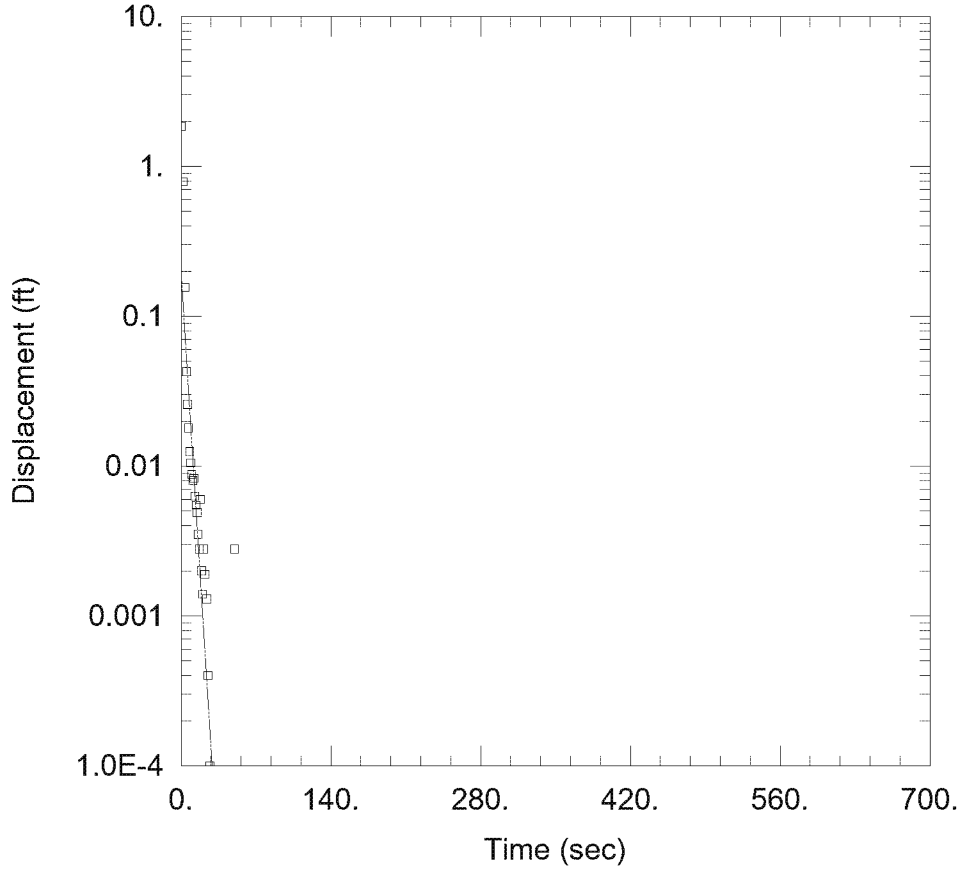
DRAWING NAME: FIGURE E–6

REV. 0

Plot: 10/02/2018 11:52 _PROGRAMS–IKEC\Clifty Creek–CCR Program\CAD\Clifty CCR MW Install\Appendix E\IKEC_Clifty MW Install_Appx E_May16 b10.dwg\E–6

APPENDIX F

AQUIFER TESTING RESULTS
May 2016



IN-A

Data Set: Y:\...\CF-15-04_IN-A-BR.aqt
Date: 08/19/16 Time: 14:14:21

PROJECT INFORMATION

Company: AGES, Inc.
Client: OVEC
Project: 2016002
Location: Clifty Creek Station
Test Well: CF-15-04
Test Date: 05/17/2016

AQUIFER DATA

Saturated Thickness: 10.16 ft Anisotropy Ratio (Kz/Kr): 1.

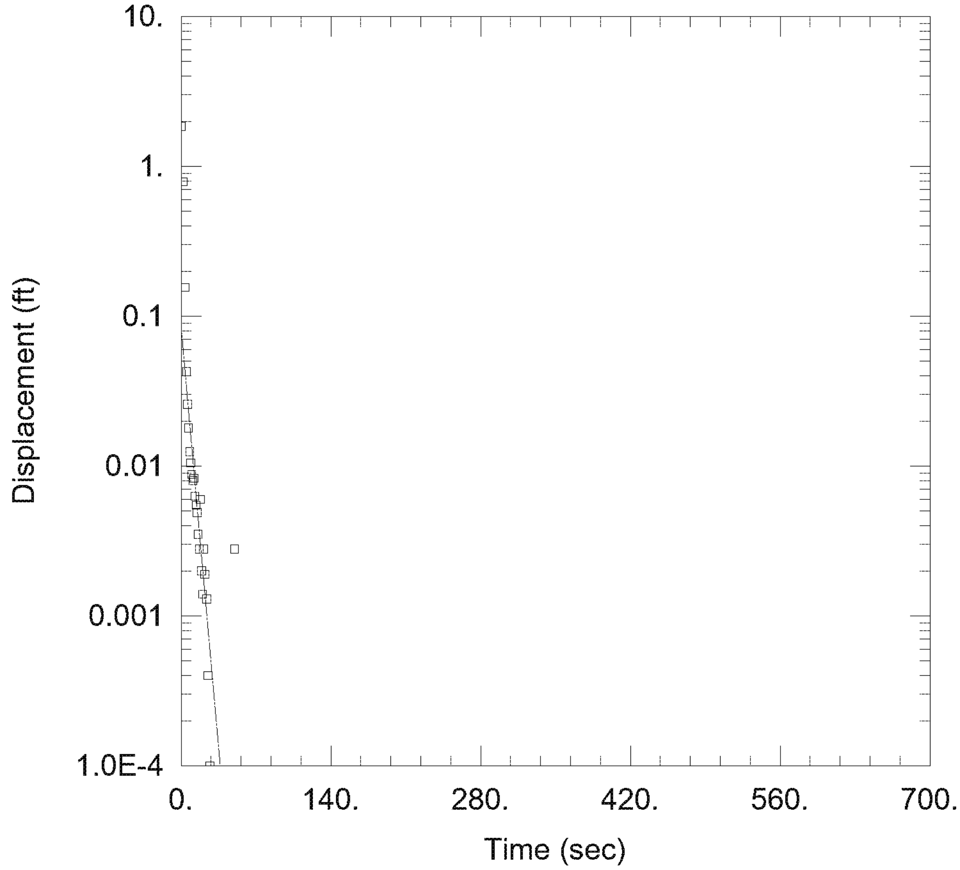
WELL DATA (CF-15-04)

Initial Displacement: 1.851 ft Static Water Column Height: 12.29 ft
Total Well Penetration Depth: 39. ft Screen Length: 10. ft
Casing Radius: 0.083 ft Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Confined Solution Method: Bouwer-Rice

K = 0.009257 cm/sec y0 = 0.2015 ft



IN-A

Data Set: Y:\...\CF-15-04_IN-A-H.aqt
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Time: 14:15:09

PROJECT INFORMATION

Company: AGES, Inc.
Client: OVEC
Project: 2016002
Location: Clifty Creek Station
Test Well: CF-15-04
Test Date: 05/17/2016

AQUIFER DATA

Saturated Thickness: 10.16 ft
Anisotropy Ratio (Kz/Kr): 1.

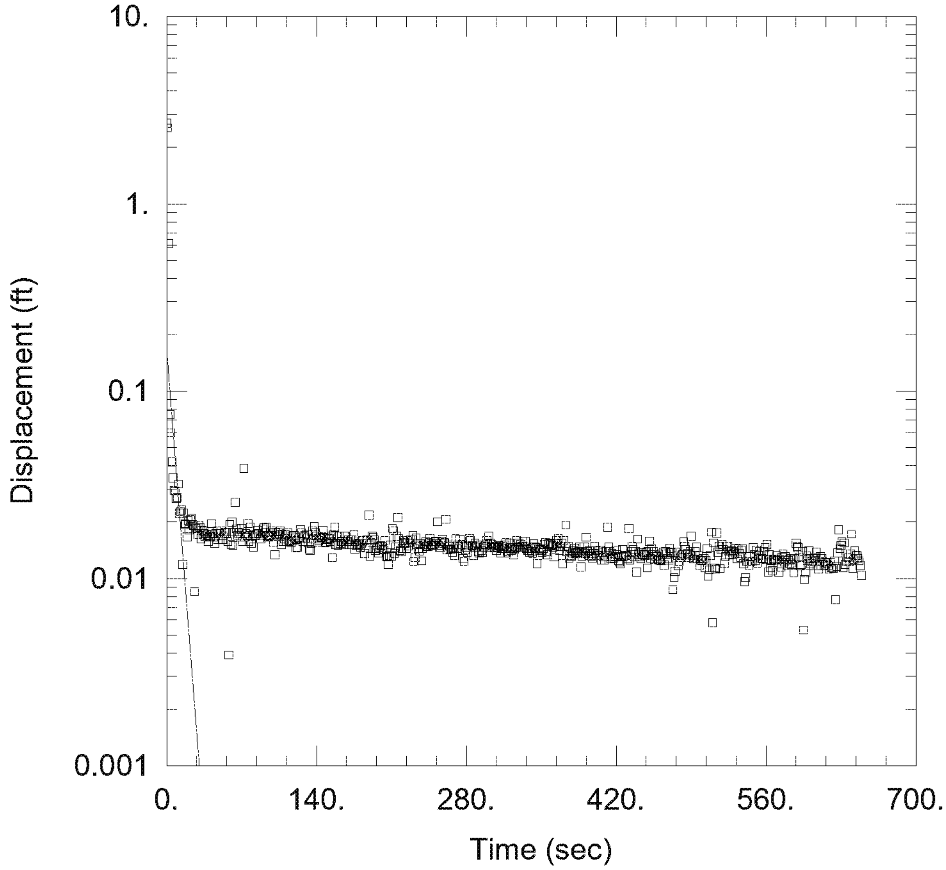
WELL DATA (CF-15-04)

Initial Displacement: 1.851 ft
Static Water Column Height: 12.29 ft
Total Well Penetration Depth: 39. ft
Screen Length: 10. ft
Casing Radius: 0.083 ft
Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Confined
Solution Method: Hvorslev

K = 0.007934 cm/sec
y0 = 0.08653 ft



IN-B

Data Set: Y:\...\CF-15-04_IN-B-BR.aqt
Date: 08/19/16 Time: 14:16:29

PROJECT INFORMATION

Company: AGES, Inc.
Client: OVEC
Project: 2016002
Location: Clifty Creek Station
Test Well: CF-15-04
Test Date: 05/17/2016

AQUIFER DATA

Saturated Thickness: 10.16 ft Anisotropy Ratio (Kz/Kr): 1.

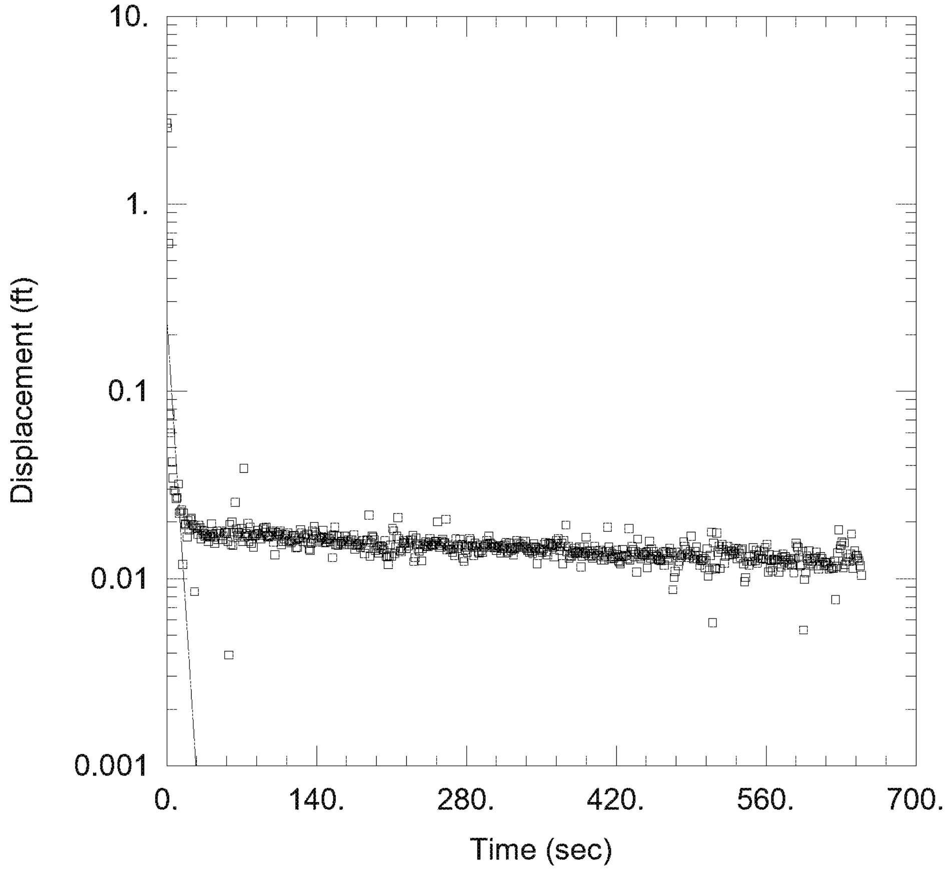
WELL DATA (CF-15-04)

Initial Displacement: 2.697 ft
Total Well Penetration Depth: 39. ft
Casing Radius: 0.083 ft
Static Water Column Height: 12.24 ft
Screen Length: 10. ft
Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Confined Solution Method: Bouwer-Rice

K = 0.005947 cm/sec y0 = 0.1693 ft



IN-B

Data Set: Y:\...\CF-15-04_IN-B-H.aqt
Date: 08/19/16 Time: 14:17:22

PROJECT INFORMATION

Company: AGES, Inc.
Client: OVEC
Project: 2016002
Location: Clifty Creek Station
Test Well: CF-15-04
Test Date: 05/17/2016

AQUIFER DATA

Saturated Thickness: 10.16 ft Anisotropy Ratio (Kz/Kr): 1.

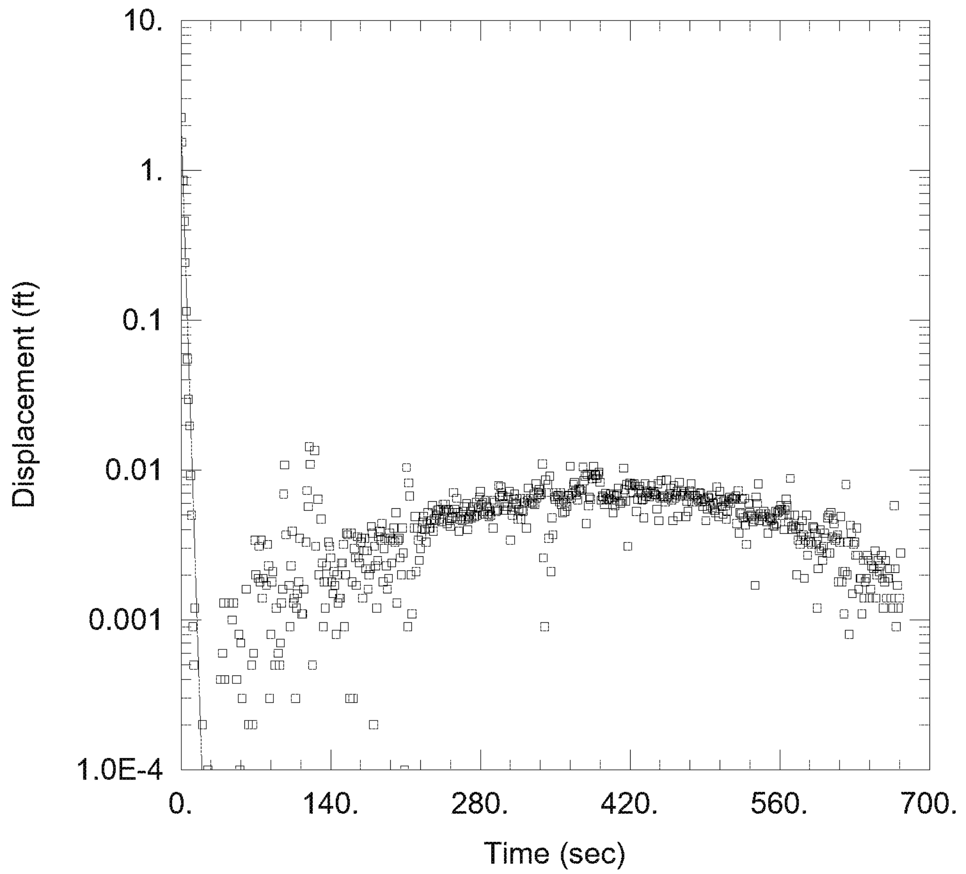
WELL DATA (CF-15-04)

Initial Displacement: 2.697 ft Static Water Column Height: 12.24 ft
Total Well Penetration Depth: 39. ft Screen Length: 10. ft
Casing Radius: 0.083 ft Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Confined Solution Method: Hvorslev

K = 0.008677 cm/sec y0 = 0.2563 ft



OUT-A

Data Set: Y:\...\CF-15-04_OUT-A-BR.aqt
Date: 08/19/16 Time: 14:18:16

PROJECT INFORMATION

Company: AGES, Inc.
Client: OVEC
Project: 2016002
Location: Clifty Creek Station
Test Well: CF-15-04
Test Date: 05/17/2016

AQUIFER DATA

Saturated Thickness: 10.16 ft Anisotropy Ratio (Kz/Kr): 1.

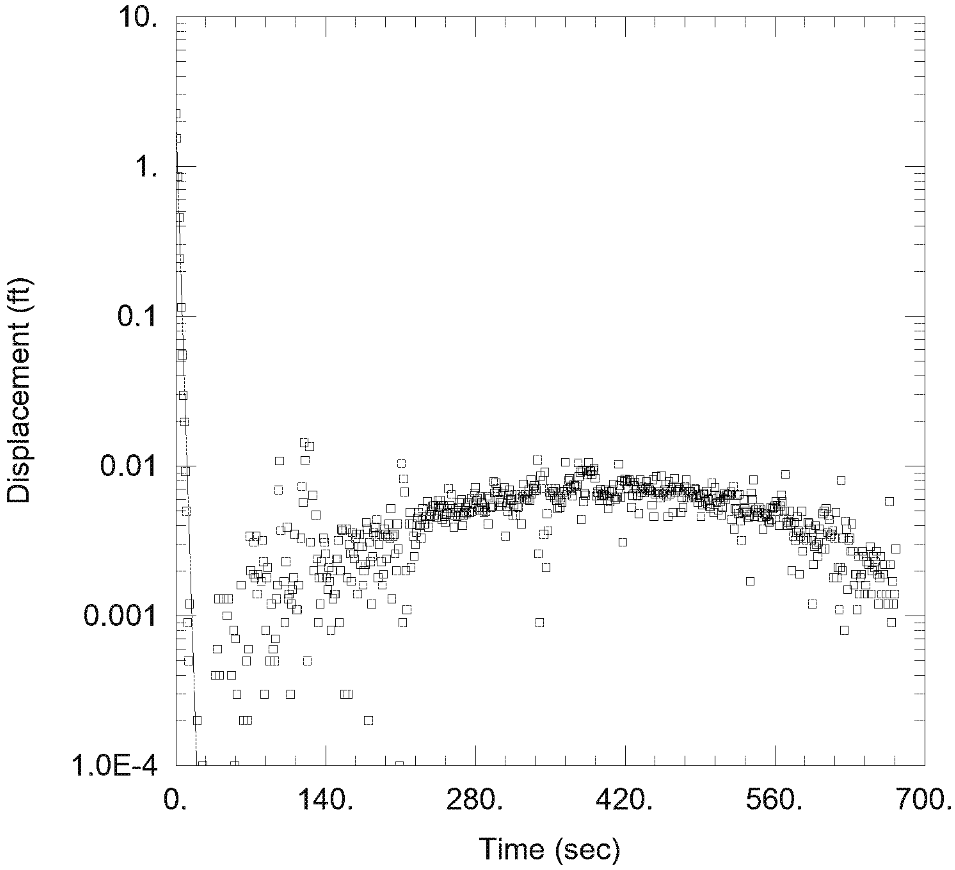
WELL DATA (CF-15-04)

Initial Displacement: 2.254 ft Static Water Column Height: 12.25 ft
Total Well Penetration Depth: 39. ft Screen Length: 10. ft
Casing Radius: 0.083 ft Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Confined Solution Method: Bouwer-Rice

K = 0.01815 cm/sec y0 = 2.326 ft



OUT-A

Data Set: Y:\...\CF-15-04_OUT-A-H.aqt
Date: 08/19/16 Time: 14:19:10

PROJECT INFORMATION

Company: AGES, Inc.
Client: OVEC
Project: 2016002
Location: Clifty Creek Station
Test Well: CF-15-04
Test Date: 05/17/2016

AQUIFER DATA

Saturated Thickness: 10.16 ft Anisotropy Ratio (Kz/Kr): 1.

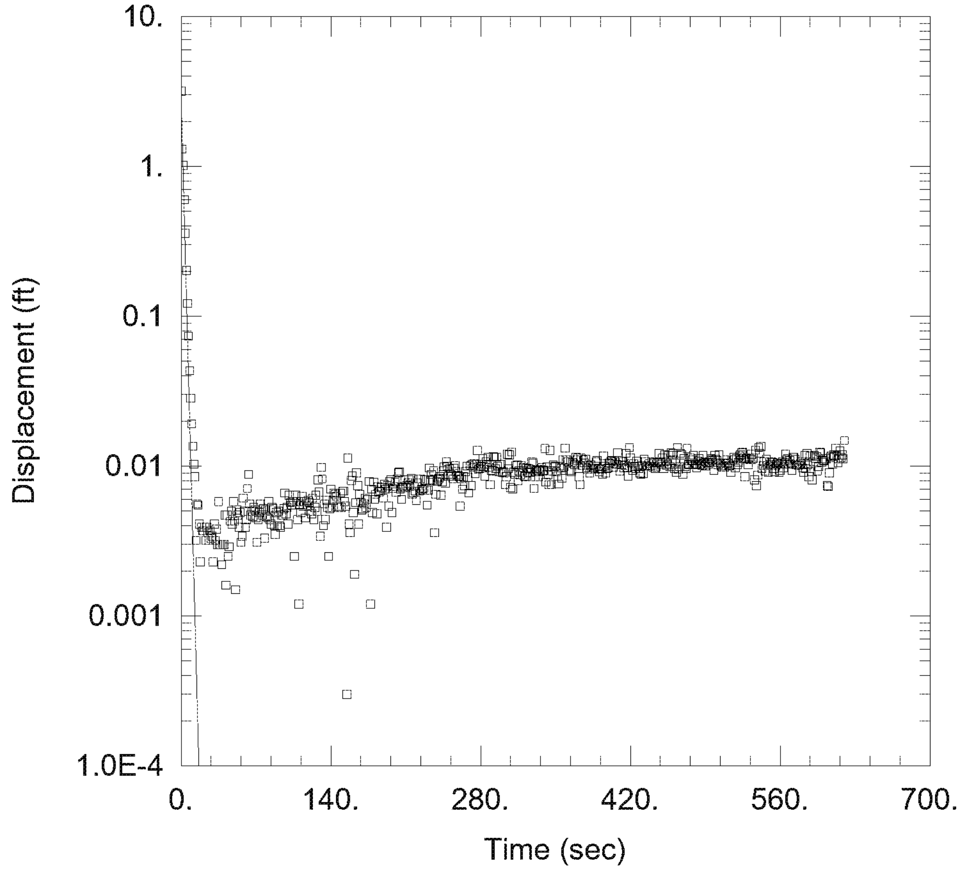
WELL DATA (CF-15-04)

Initial Displacement: 2.254 ft Static Water Column Height: 12.25 ft
Total Well Penetration Depth: 39. ft Screen Length: 10. ft
Casing Radius: 0.083 ft Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Confined Solution Method: Hvorslev

K = 0.02206 cm/sec y0 = 2.326 ft



OUT-B

Data Set: Y:\...\CF-15-04_OUT-B-BR.aqt
Date: 08/19/16 Time: 14:20:16

PROJECT INFORMATION

Company: AGES, Inc.
Client: OVEC
Project: 2016002
Location: Clifty Creek Station
Test Well: CF-15-04
Test Date: 05/17/2016

AQUIFER DATA

Saturated Thickness: 10.16 ft Anisotropy Ratio (Kz/Kr): 1.

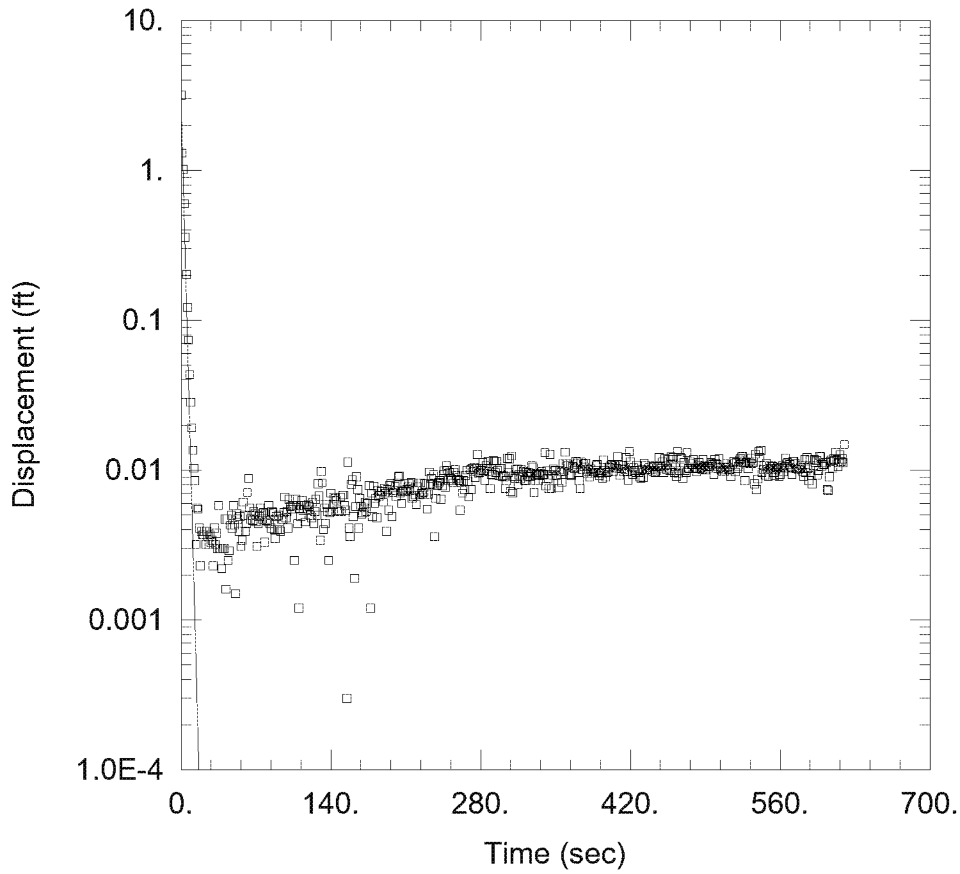
WELL DATA (CF-15-04)

Initial Displacement: 3.18 ft
Total Well Penetration Depth: 39. ft
Casing Radius: 0.083 ft
Static Water Column Height: 12.25 ft
Screen Length: 10. ft
Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Confined Solution Method: Bouwer-Rice

K = 0.02184 cm/sec y0 = 3.061 ft



OUT-B

Data Set: Y:\...\CF-15-04_OUT-B-H.aqt
Date: 08/19/16 Time: 14:21:26

PROJECT INFORMATION

Company: AGES, Inc.
Client: OVEC
Project: 2016002
Location: Clifty Creek Station
Test Well: CF-15-04
Test Date: 05/17/2016

AQUIFER DATA

Saturated Thickness: 10.16 ft Anisotropy Ratio (Kz/Kr): 1.

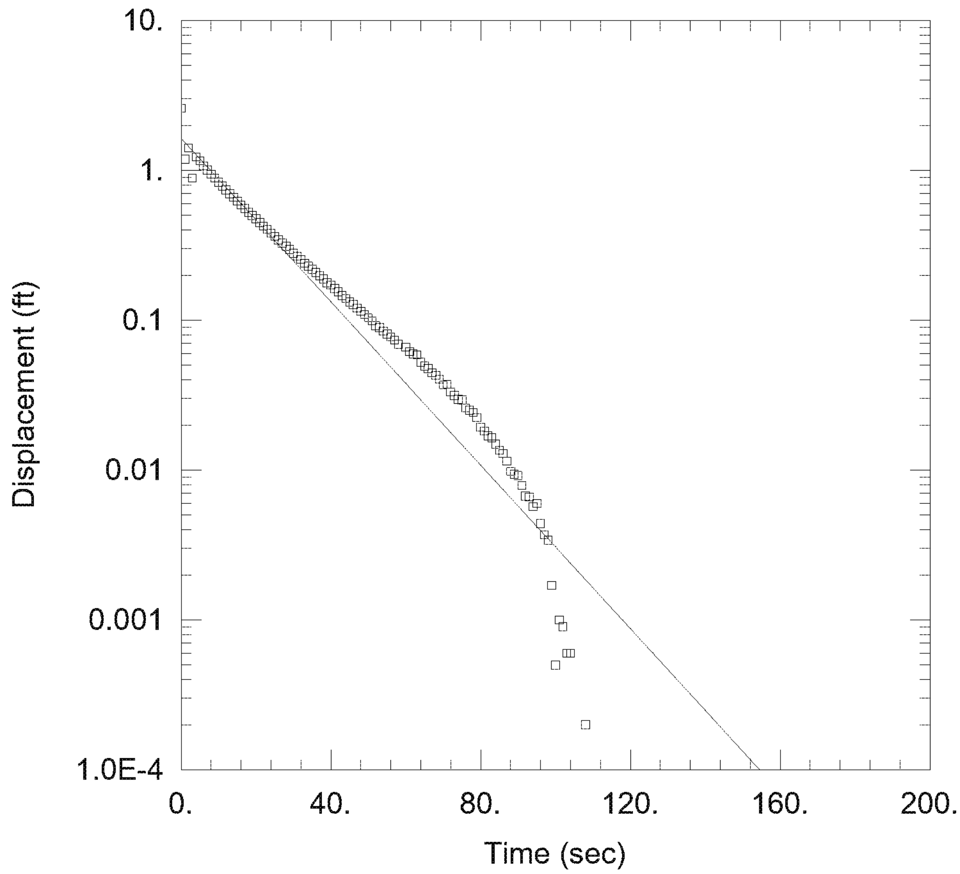
WELL DATA (CF-15-04)

Initial Displacement: 3.18 ft Static Water Column Height: 12.25 ft
Total Well Penetration Depth: 39. ft Screen Length: 10. ft
Casing Radius: 0.083 ft Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Confined Solution Method: Hvorslev

K = 0.02651 cm/sec y0 = 3.061 ft



IN-A

Data Set: Y:\...\CF-15-08_IN-A-BR.aqt
Date: 08/19/16 Time: 14:22:21

PROJECT INFORMATION

Company: AGES, Inc.
Client: OVEC
Project: 2016002
Location: Clifty Creek Station
Test Well: CF-15-08
Test Date: 05/16/2016

AQUIFER DATA

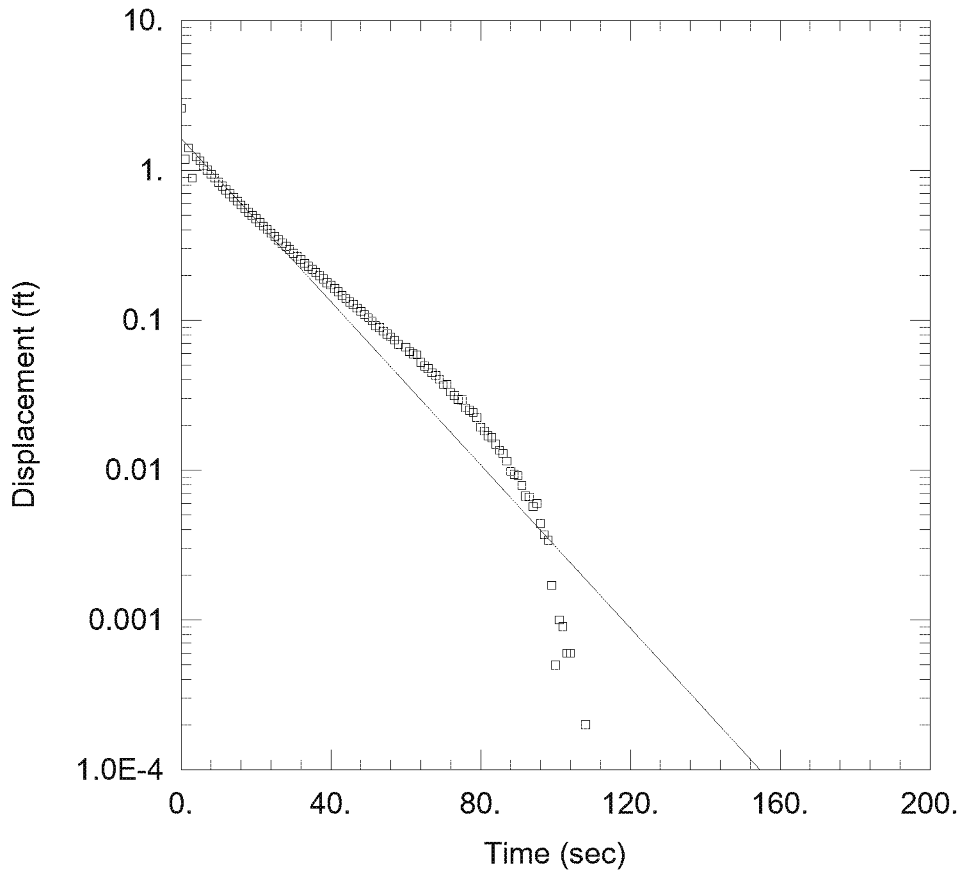
Saturated Thickness: 20.05 ft Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (CF-15-08)

Initial Displacement: 2.599 ft Static Water Column Height: 22.6 ft
Total Well Penetration Depth: 41. ft Screen Length: 10. ft
Casing Radius: 0.083 ft Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Confined Solution Method: Bouwer-Rice
K = 0.002241 cm/sec y0 = 1.646 ft



IN-A

Data Set: Y:\...\CF-15-08_IN-A-H.aqt
Date: 08/19/16 Time: 14:23:18

PROJECT INFORMATION

Company: AGES, Inc.
Client: OVEC
Project: 2016002
Location: Clifty Creek Station
Test Well: CF-15-08
Test Date: 05/16/2016

AQUIFER DATA

Saturated Thickness: 20.05 ft Anisotropy Ratio (Kz/Kr): 1.

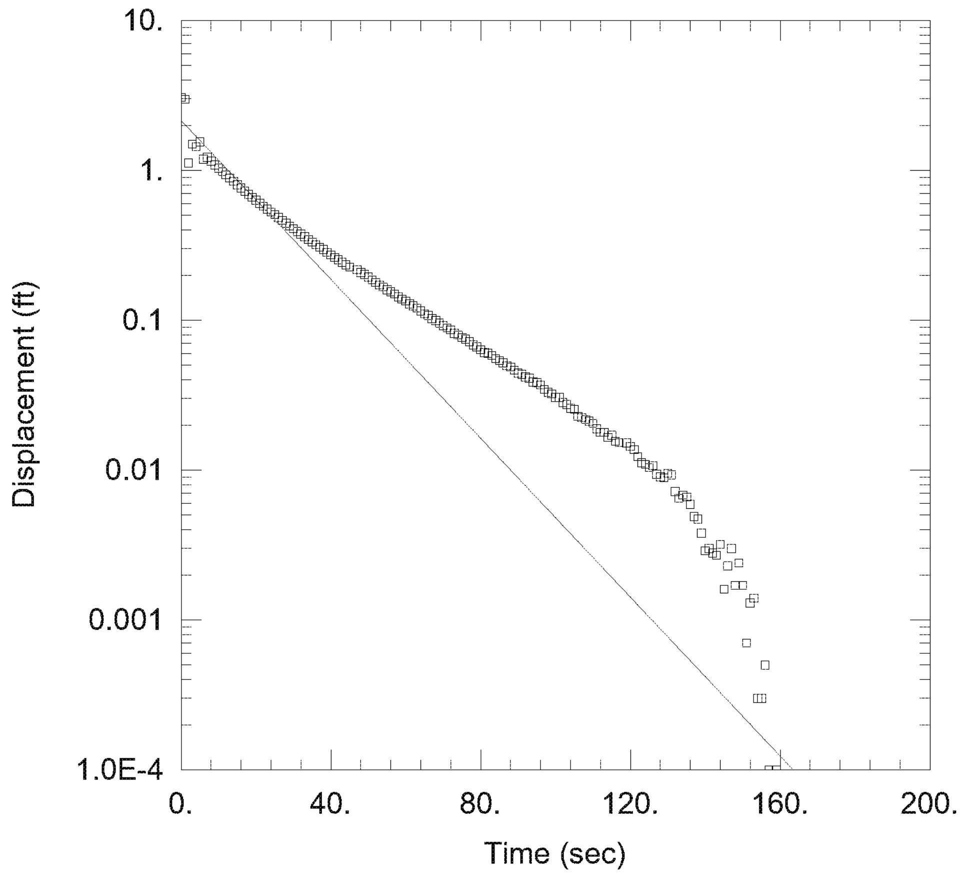
WELL DATA (CF-15-08)

Initial Displacement: 2.599 ft Static Water Column Height: 22.6 ft
Total Well Penetration Depth: 41. ft Screen Length: 10. ft
Casing Radius: 0.083 ft Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Confined Solution Method: Hvorslev

K = 0.002698 cm/sec y0 = 1.645 ft



IN-B

Data Set: Y:\...\CF-15-08_IN-B-BR.aqt
Date: 08/19/16 Time: 14:24:13

PROJECT INFORMATION

Company: AGES, Inc.
Client: OVEC
Project: 2016002
Location: Clifty Creek Station
Test Well: CF-15-08
Test Date: 05/16/2016

AQUIFER DATA

Saturated Thickness: 20.05 ft Anisotropy Ratio (Kz/Kr): 1.

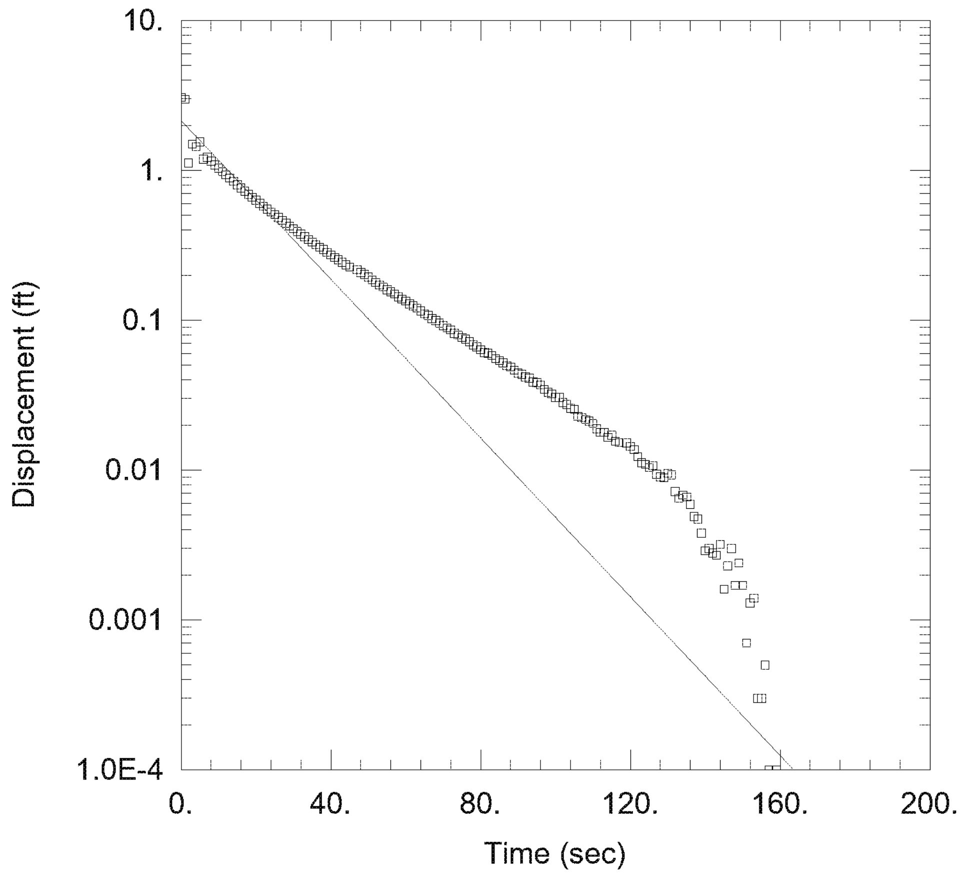
WELL DATA (CF-15-08)

Initial Displacement: 3.077 ft Static Water Column Height: 22.61 ft
Total Well Penetration Depth: 41. ft Screen Length: 10. ft
Casing Radius: 0.083 ft Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Confined Solution Method: Bouwer-Rice

K = 0.002179 cm/sec y0 = 2.164 ft



IN-B

Data Set: Y:\...\CF-15-08_IN-B-H.aqt
Date: 08/19/16 Time: 14:25:06

PROJECT INFORMATION

Company: AGES, Inc.
Client: OVEC
Project: 2016002
Location: Clifty Creek Station
Test Well: CF-15-08
Test Date: 05/16/2016

AQUIFER DATA

Saturated Thickness: 20.05 ft Anisotropy Ratio (Kz/Kr): 1.

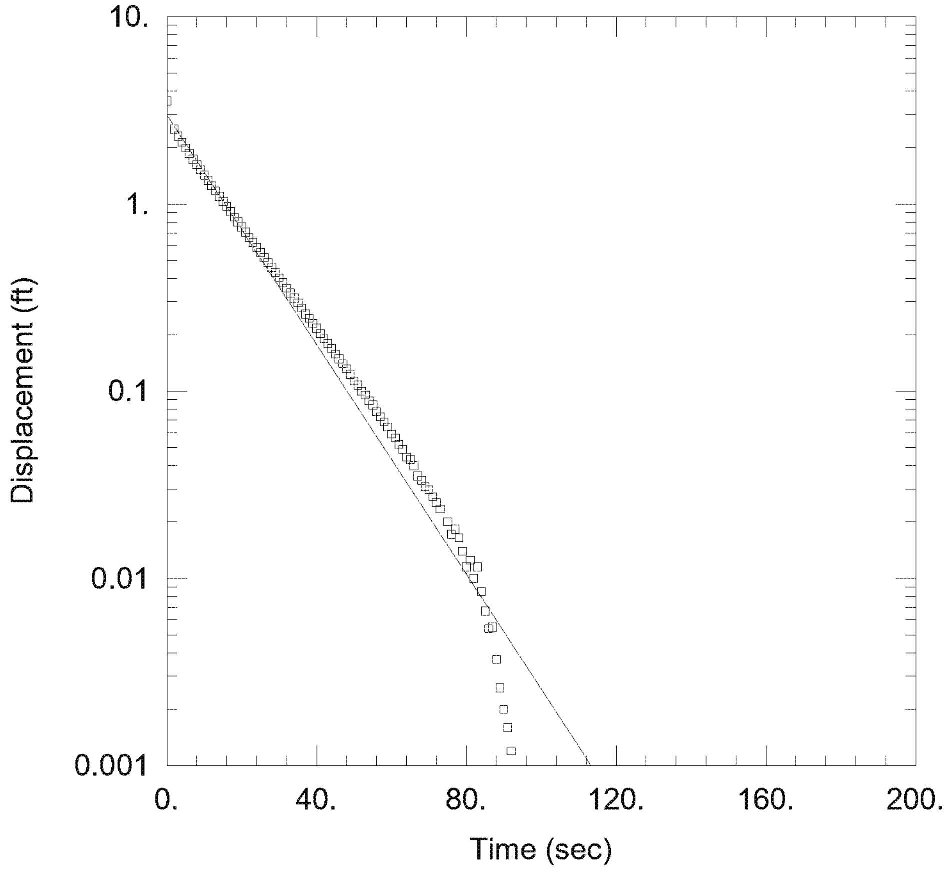
WELL DATA (CF-15-08)

Initial Displacement: 3.077 ft Static Water Column Height: 22.61 ft
Total Well Penetration Depth: 41. ft Screen Length: 10. ft
Casing Radius: 0.083 ft Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Confined Solution Method: Hvorslev

K = 0.002622 cm/sec y0 = 2.163 ft



OUT-A

Data Set: Y:\...\CF-15-08_OUT-A-BR.aqt
Date: 08/19/16 Time: 14:25:52

PROJECT INFORMATION

Company: AGES, Inc.
Client: OVEC
Project: 2016002
Location: Clifty Creek Station
Test Well: CF-15-08
Test Date: 05/16/2016

AQUIFER DATA

Saturated Thickness: 20.05 ft
Anisotropy Ratio (Kz/Kr): 1.

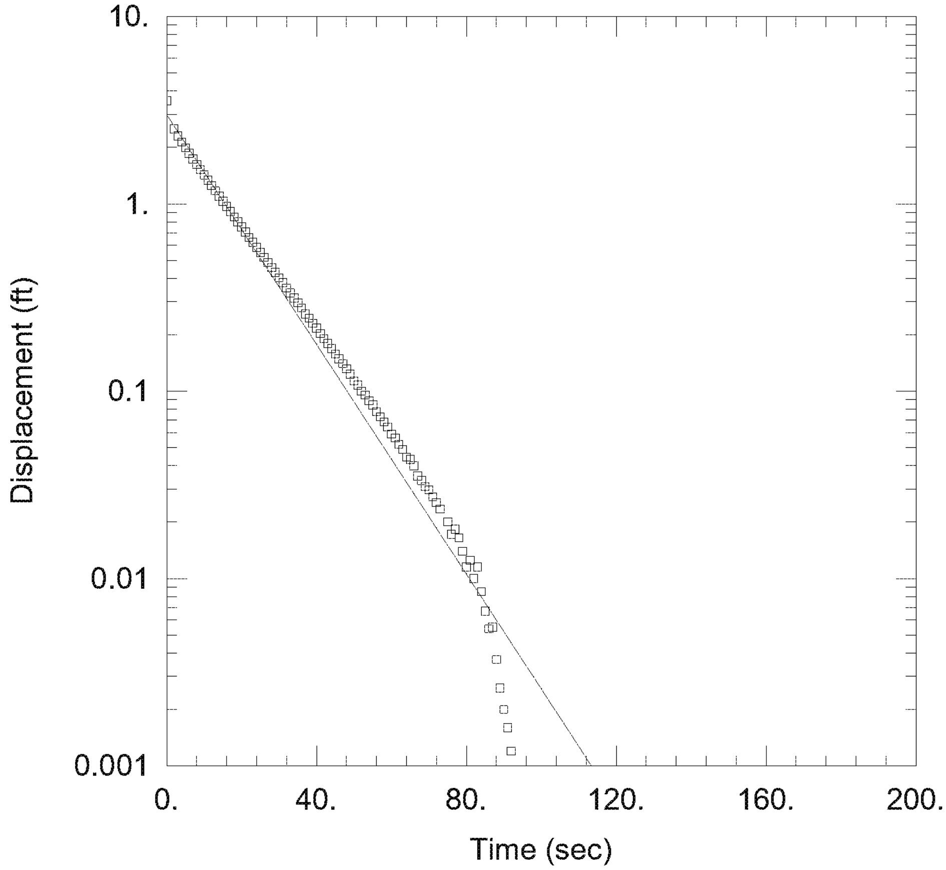
WELL DATA (CF-15-08)

Initial Displacement: 3.549 ft
Static Water Column Height: 22.6 ft
Total Well Penetration Depth: 41. ft
Screen Length: 10. ft
Casing Radius: 0.083 ft
Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice

K = 0.002521 cm/sec
y0 = 3.006 ft



OUT-A

Data Set: Y:\...\CF-15-08_OUT-A-H.aqt
Date: 08/19/16 Time: 14:26:41

PROJECT INFORMATION

Company: AGES, Inc.
Client: OVEC
Project: 2016002
Location: Clifty Creek Station
Test Well: CF-15-08
Test Date: 05/16/2016

AQUIFER DATA

Saturated Thickness: 20.05 ft Anisotropy Ratio (Kz/Kr): 1.

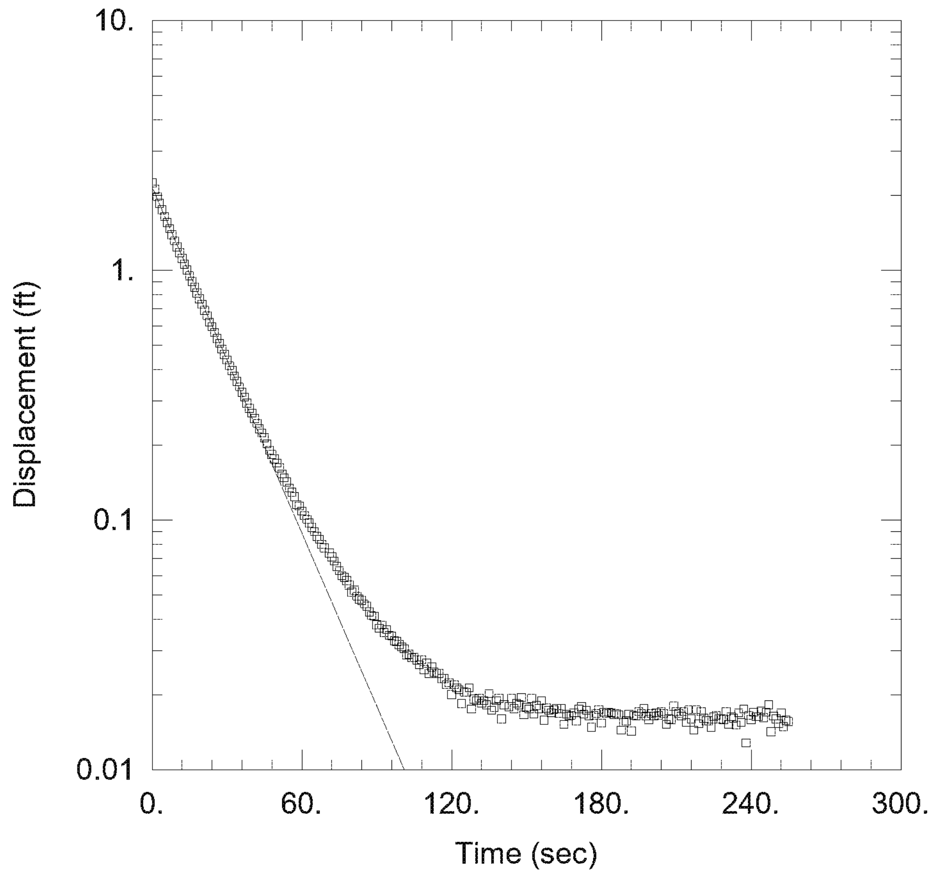
WELL DATA (CF-15-08)

Initial Displacement: 3.549 ft Static Water Column Height: 22.6 ft
Total Well Penetration Depth: 41. ft Screen Length: 10. ft
Casing Radius: 0.083 ft Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Confined Solution Method: Hvorslev

K = 0.003035 cm/sec y0 = 3.005 ft



OUT-B

Data Set: Y:\...\CF-15-08_OUT-B-BR.aqt
Date: 08/19/16 Time: 14:27:29

PROJECT INFORMATION

Company: AGES, Inc.
Client: OVEC
Project: 2016002
Location: Clifty Creek Station
Test Well: CF-15-08
Test Date: 05/16/2016

AQUIFER DATA

Saturated Thickness: 20.05 ft
Anisotropy Ratio (Kz/Kr): 1.

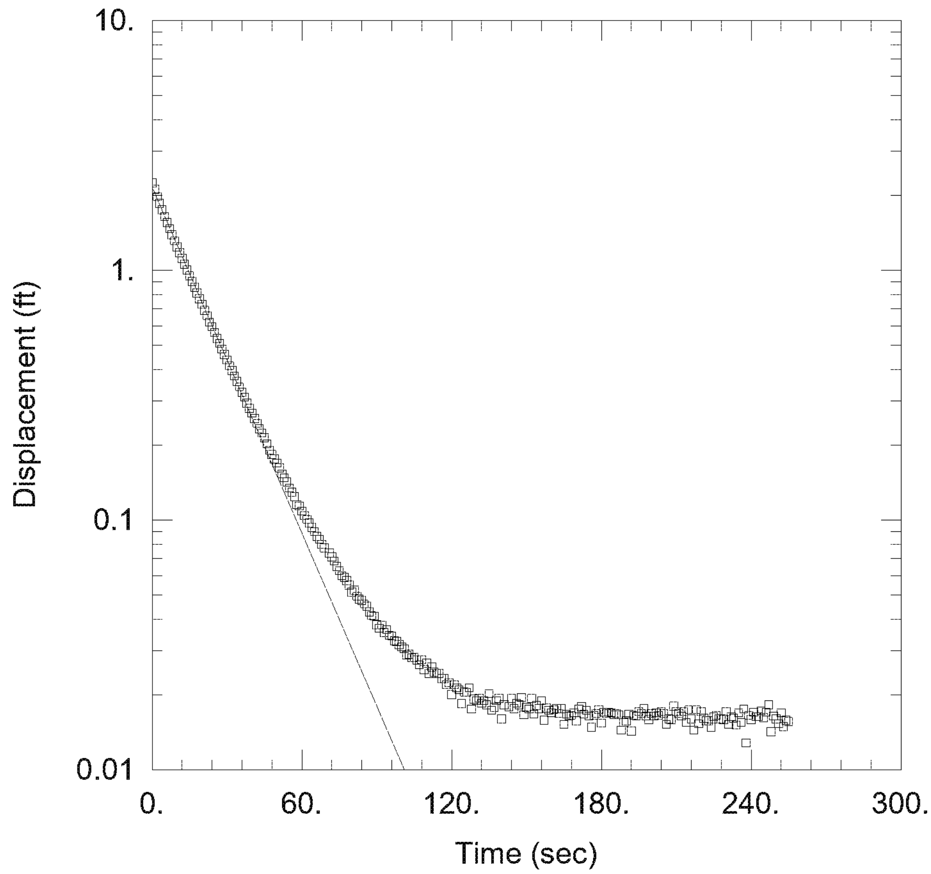
WELL DATA (CF-15-08)

Initial Displacement: 2.239 ft
Static Water Column Height: 22.6 ft
Total Well Penetration Depth: 41. ft
Screen Length: 10. ft
Casing Radius: 0.083 ft
Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice

K = 0.001898 cm/sec
y0 = 2.162 ft



OUT-B

Data Set: Y:\...\CF-15-08_OUT-B-H.aqt
Date: 08/19/16 Time: 14:28:16

PROJECT INFORMATION

Company: AGES, Inc.
Client: OVEC
Project: 2016002
Location: Clifty Creek Station
Test Well: CF-15-08
Test Date: 05/16/2016

AQUIFER DATA

Saturated Thickness: 20.05 ft Anisotropy Ratio (Kz/Kr): 1.

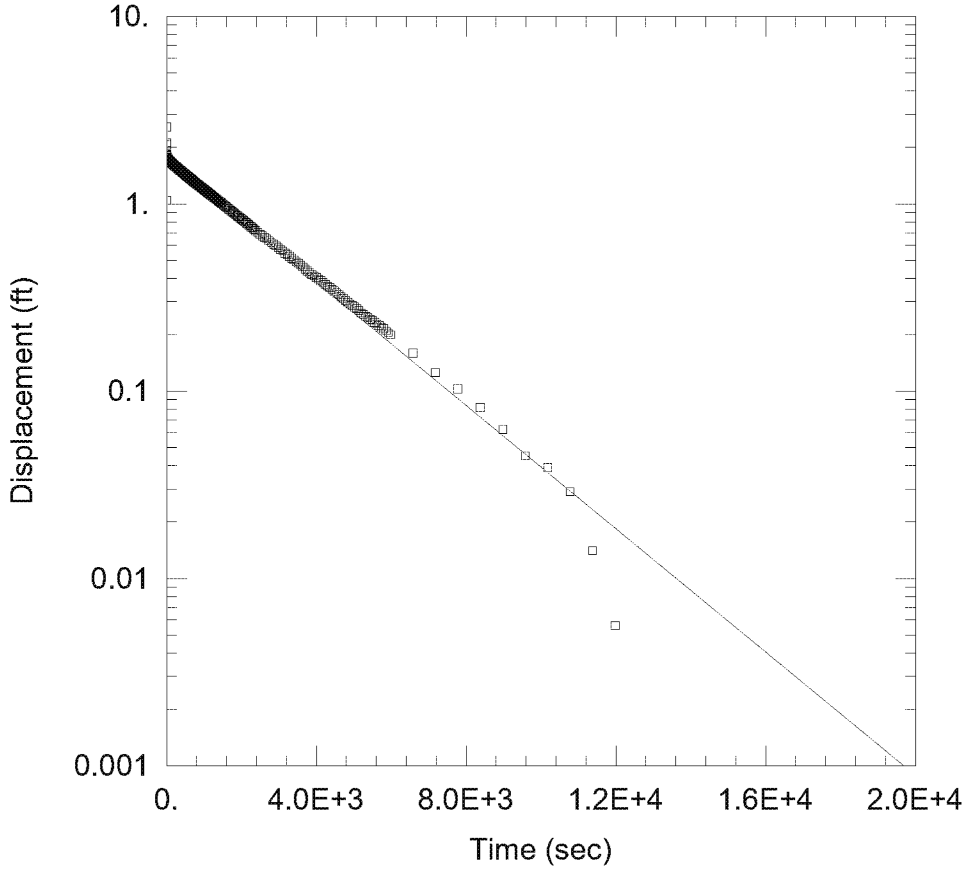
WELL DATA (CF-15-08)

Initial Displacement: 2.239 ft
Total Well Penetration Depth: 41. ft
Casing Radius: 0.083 ft
Static Water Column Height: 22.6 ft
Screen Length: 10. ft
Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Confined Solution Method: Hvorslev

K = 0.002285 cm/sec y0 = 2.161 ft



IN-B

Data Set: Y:\...\WBSP-15-02_IN-B-BR.aqt
Date: 08/19/16 Time: 14:30:08

PROJECT INFORMATION

Company: AGES, Inc.
Client: OVEC
Project: 2016002
Location: Clifty Creek Station
Test Well: WBSP-15-02
Test Date: 05/17/2016

AQUIFER DATA

Saturated Thickness: 17.61 ft Anisotropy Ratio (Kz/Kr): 1.

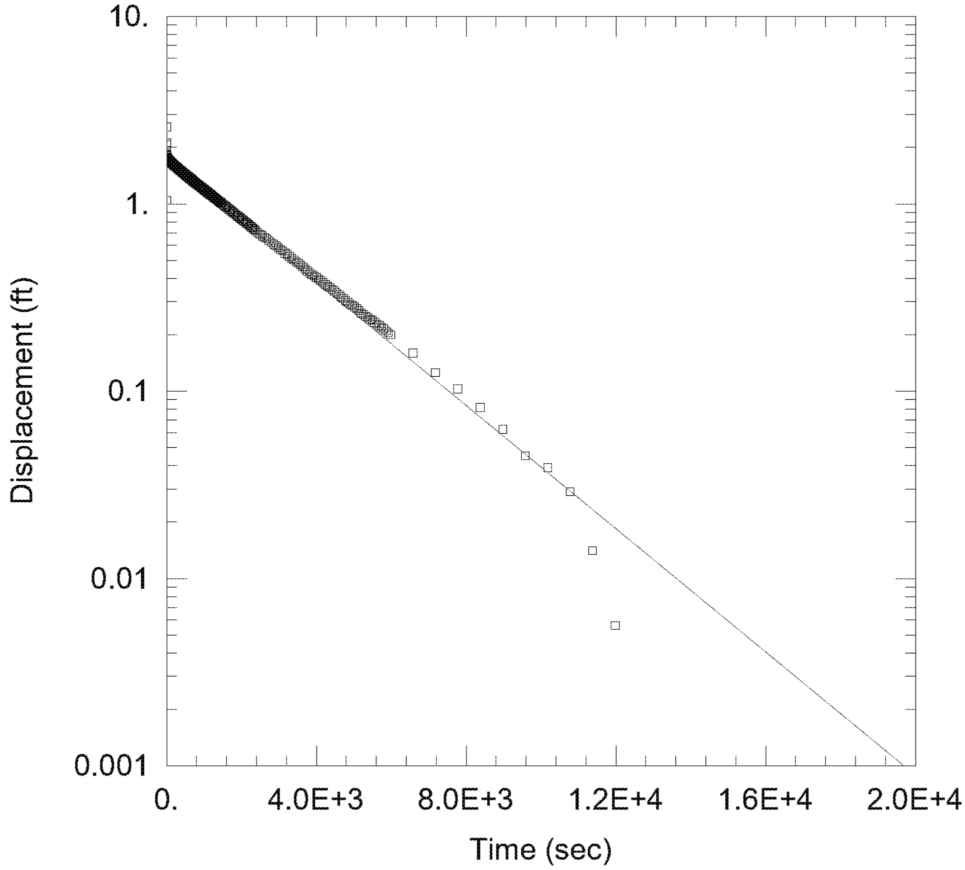
WELL DATA (WBSP-15-02)

Initial Displacement: 2.57 ft
Total Well Penetration Depth: 24. ft
Casing Radius: 0.083 ft
Static Water Column Height: 17.83 ft
Screen Length: 10. ft
Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Confined Solution Method: Bouwer-Rice

K = 1.232E-5 cm/sec y0 = 1.741 ft



IN-B

Data Set: Y:\...\WBSP-15-02_IN-B-H.aqt
Date: 08/19/16 Time: 14:30:41

PROJECT INFORMATION

Company: AGES, Inc.
Client: OVEC
Project: 2016002
Location: Clifty Creek Station
Test Well: WBSP-15-02
Test Date: 05/17/2016

AQUIFER DATA

Saturated Thickness: 17.61 ft
Anisotropy Ratio (Kz/Kr): 1.

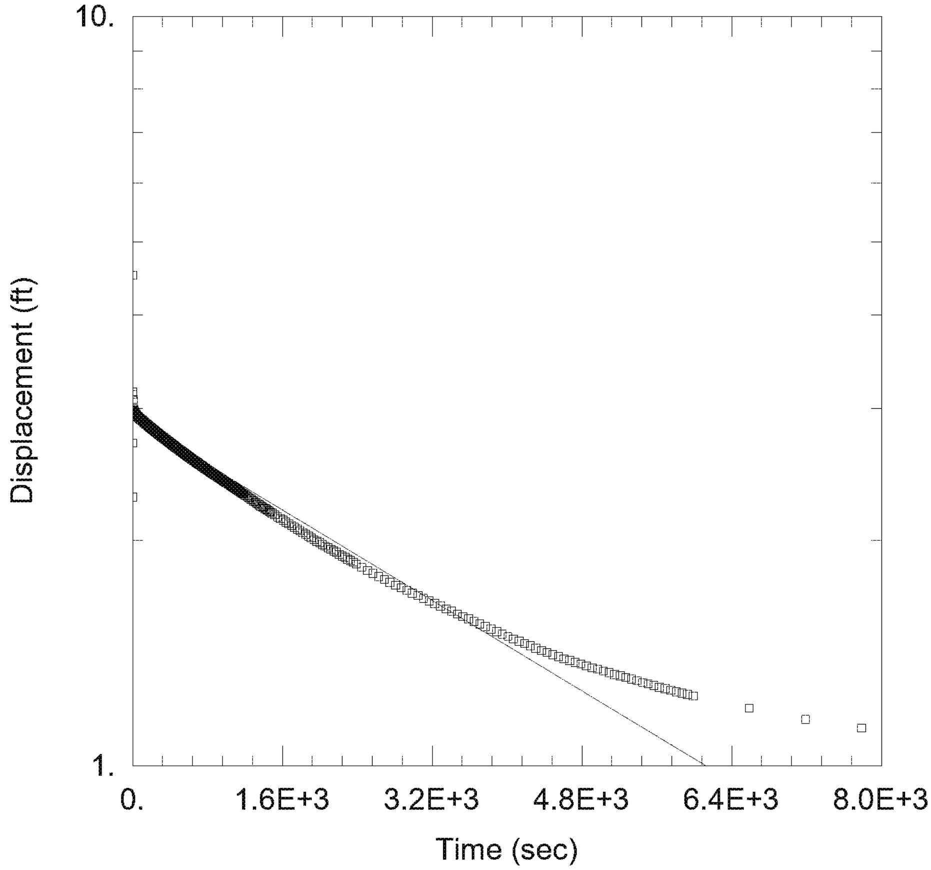
WELL DATA (WBSP-15-02)

Initial Displacement: 2.57 ft
Static Water Column Height: 17.83 ft
Total Well Penetration Depth: 24. ft
Screen Length: 10. ft
Casing Radius: 0.083 ft
Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Confined
Solution Method: Hvorslev

K = 1.629E-5 cm/sec
y0 = 1.741 ft



OUT-A

Data Set: Y:\...\WBSP-15-02_OUT-A-BR.aqt
Date: 08/19/16 Time: 14:31:45

PROJECT INFORMATION

Company: AGES, Inc.
Client: OVEC
Project: 2016002
Location: Clifty Creek Station
Test Well: WBSP-15-02
Test Date: 05/17/2016

AQUIFER DATA

Saturated Thickness: 17.61 ft Anisotropy Ratio (Kz/Kr): 1.

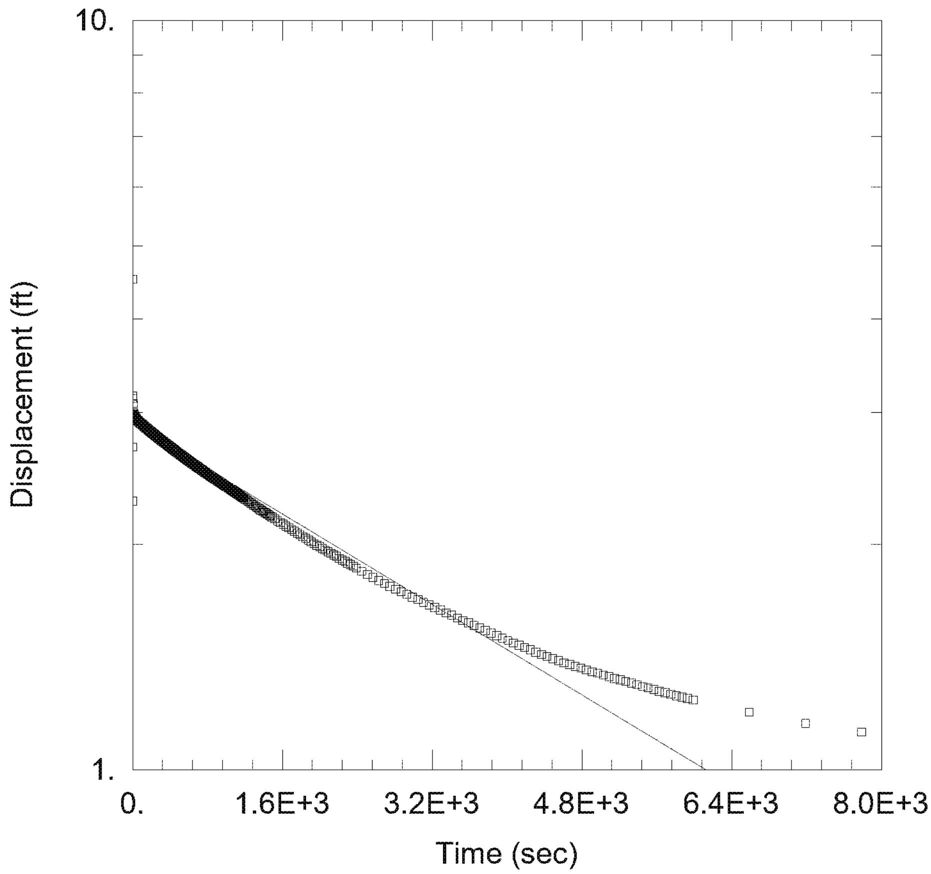
WELL DATA (WBSP-15-02)

Initial Displacement: 4.516 ft Static Water Column Height: 20.8 ft
Total Well Penetration Depth: 24. ft Screen Length: 10. ft
Casing Radius: 0.083 ft Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Confined Solution Method: Bouwer-Rice

K = 5.652E-6 cm/sec y0 = 2.9 ft



OUT-A

Data Set: Y:\...\WBSP-15-02_OUT-A-H.aqt
Date: 08/19/16 Time: 14:32:32

PROJECT INFORMATION

Company: AGES, Inc.
Client: OVEC
Project: 2016002
Location: Clifty Creek Station
Test Well: WBSP-15-02
Test Date: 05/17/2016

AQUIFER DATA

Saturated Thickness: 17.61 ft
Anisotropy Ratio (Kz/Kr): 1.

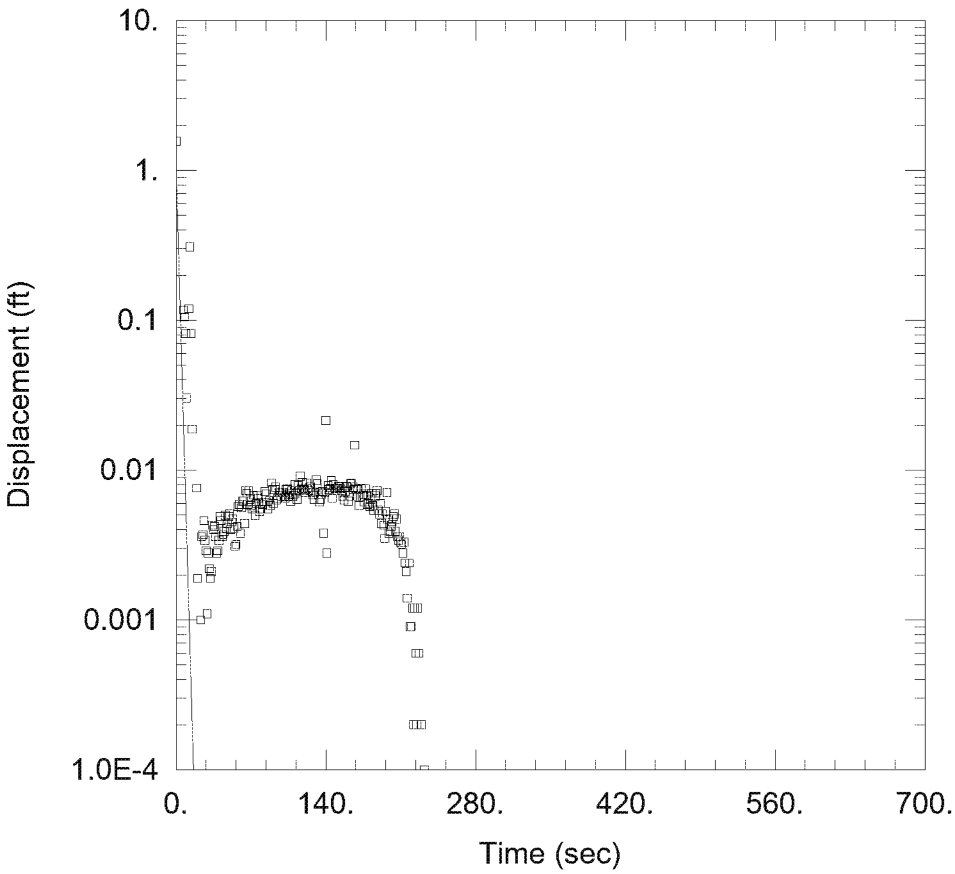
WELL DATA (WBSP-15-02)

Initial Displacement: 4.516 ft
Total Well Penetration Depth: 24. ft
Casing Radius: 0.083 ft
Static Water Column Height: 20.8 ft
Screen Length: 10. ft
Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Confined
Solution Method: Hvorslev

K = 7.471E-6 cm/sec
y0 = 2.9 ft



IN-A

Data Set: Y:\...\WBSP-15-06_IN-A-BR.aqt
Date: 08/19/16 Time: 14:33:29

PROJECT INFORMATION

Company: AGES, Inc.
Client: OVEC
Project: 2016002
Location: Clifty Creek Station
Test Well: WBSP-15-06
Test Date: 05/17/2016

AQUIFER DATA

Saturated Thickness: 40.81 ft Anisotropy Ratio (Kz/Kr): 1.

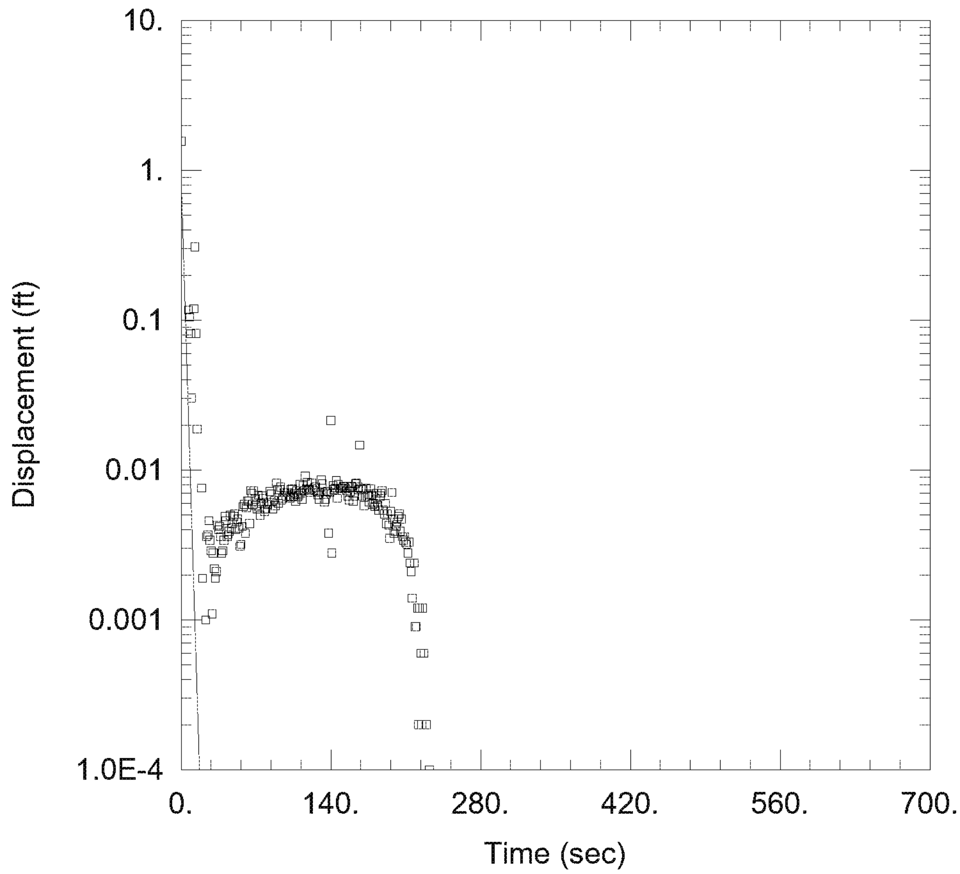
WELL DATA (WBSP-15-06)

Initial Displacement: 1.565 ft Static Water Column Height: 26.69 ft
Total Well Penetration Depth: 89. ft Screen Length: 10. ft
Casing Radius: 0.083 ft Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Confined Solution Method: Bouwer-Rice

K = 0.02271 cm/sec y0 = 1.09 ft



IN-A

Data Set: Y:\...\WBSP-15-06_IN-A-H.aqt
Date: 08/19/16 Time: 14:34:42

PROJECT INFORMATION

Company: AGES, Inc.
Client: OVEC
Project: 2016002
Location: Clifty Creek Station
Test Well: WBSP-15-06
Test Date: 05/17/2016

AQUIFER DATA

Saturated Thickness: 40.81 ft Anisotropy Ratio (Kz/Kr): 1.

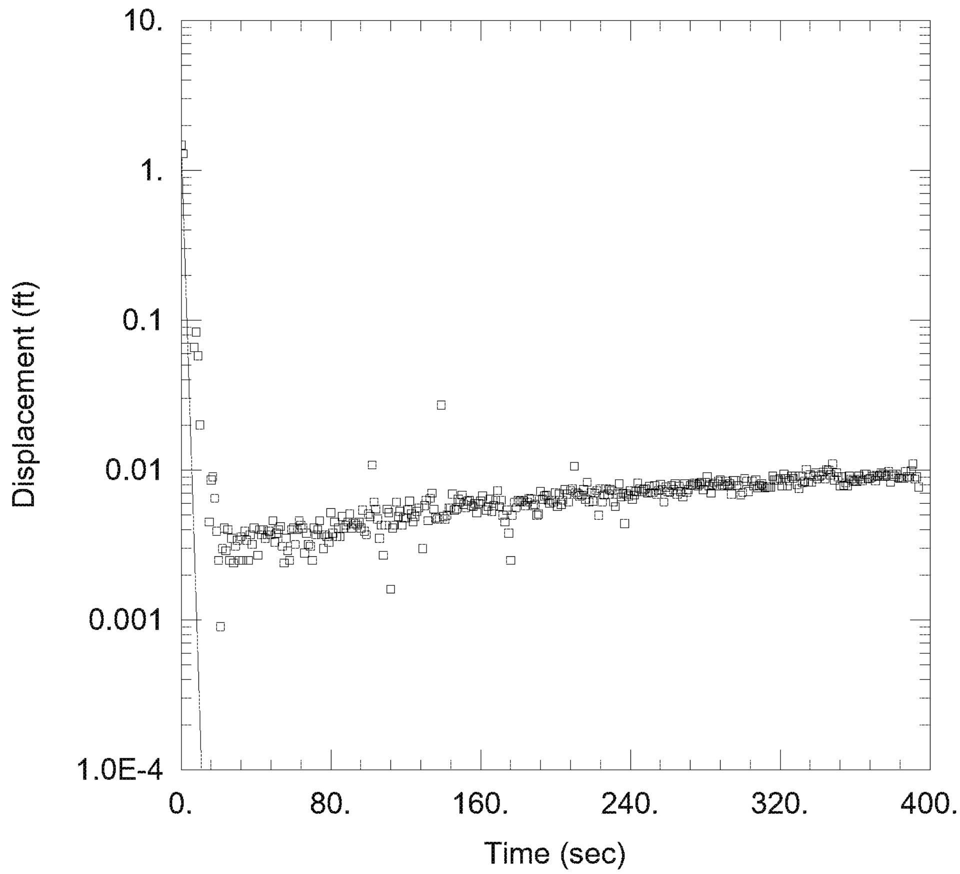
WELL DATA (WBSP-15-06)

Initial Displacement: 1.565 ft
Total Well Penetration Depth: 89. ft
Casing Radius: 0.083 ft
Static Water Column Height: 26.69 ft
Screen Length: 10. ft
Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Confined Solution Method: Hvorslev

K = 0.02271 cm/sec y0 = 0.922 ft



IN-B

Data Set: Y:\...\WBSP-15-06_IN-B-BR.aqt
Date: 08/19/16 Time: 14:35:56

PROJECT INFORMATION

Company: AGES, Inc.
Client: OVEC
Project: 2016002
Location: Clifty Creek Station
Test Well: WBSP-15-06
Test Date: 05/17/2016

AQUIFER DATA

Saturated Thickness: 40.81 ft Anisotropy Ratio (Kz/Kr): 1.

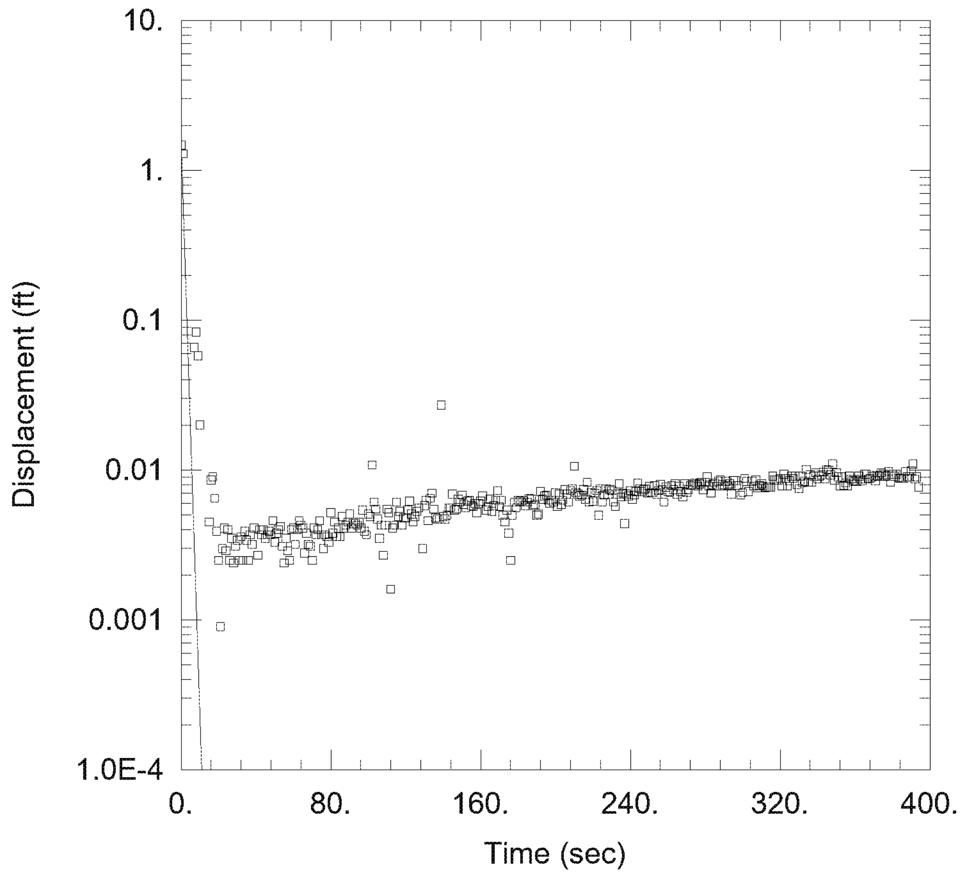
WELL DATA (WBSP-15-06)

Initial Displacement: 1.472 ft
Total Well Penetration Depth: 89. ft
Casing Radius: 0.083 ft
Static Water Column Height: 26.64 ft
Screen Length: 10. ft
Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Confined Solution Method: Bouwer-Rice

K = 0.03521 cm/sec y0 = 1.629 ft



IN-B

Data Set: Y:\...\WBSP-15-06_IN-B-H.aqt
Date: 08/19/16 Time: 14:37:05

PROJECT INFORMATION

Company: AGES, Inc.
Client: OVEC
Project: 2016002
Location: Clifty Creek Station
Test Well: WBSP-15-06
Test Date: 05/17/2016

AQUIFER DATA

Saturated Thickness: 40.81 ft Anisotropy Ratio (Kz/Kr): 1.

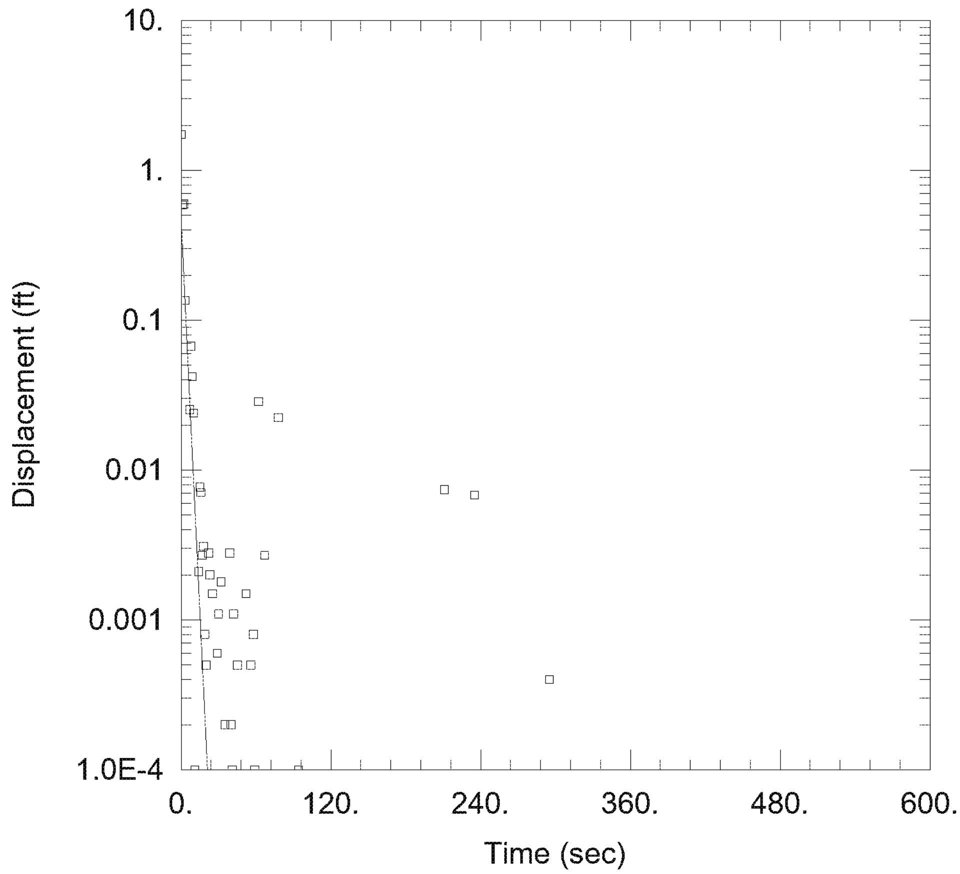
WELL DATA (WBSP-15-06)

Initial Displacement: 1.472 ft
Total Well Penetration Depth: 89. ft
Casing Radius: 0.083 ft
Static Water Column Height: 26.64 ft
Screen Length: 10. ft
Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Confined Solution Method: Hvorslev

K = 0.03781 cm/sec y0 = 1.628 ft



OUT-A

Data Set: Y:\...\WBSP-15-06_OUT-A-BR.aqt
Date: 08/19/16 Time: 14:38:02

PROJECT INFORMATION

Company: AGES, Inc.
Client: OVEC
Project: 2016002
Location: Clifty Creek Station
Test Well: WBSP-15-06
Test Date: 05/17/2016

AQUIFER DATA

Saturated Thickness: 40.81 ft Anisotropy Ratio (Kz/Kr): 1.

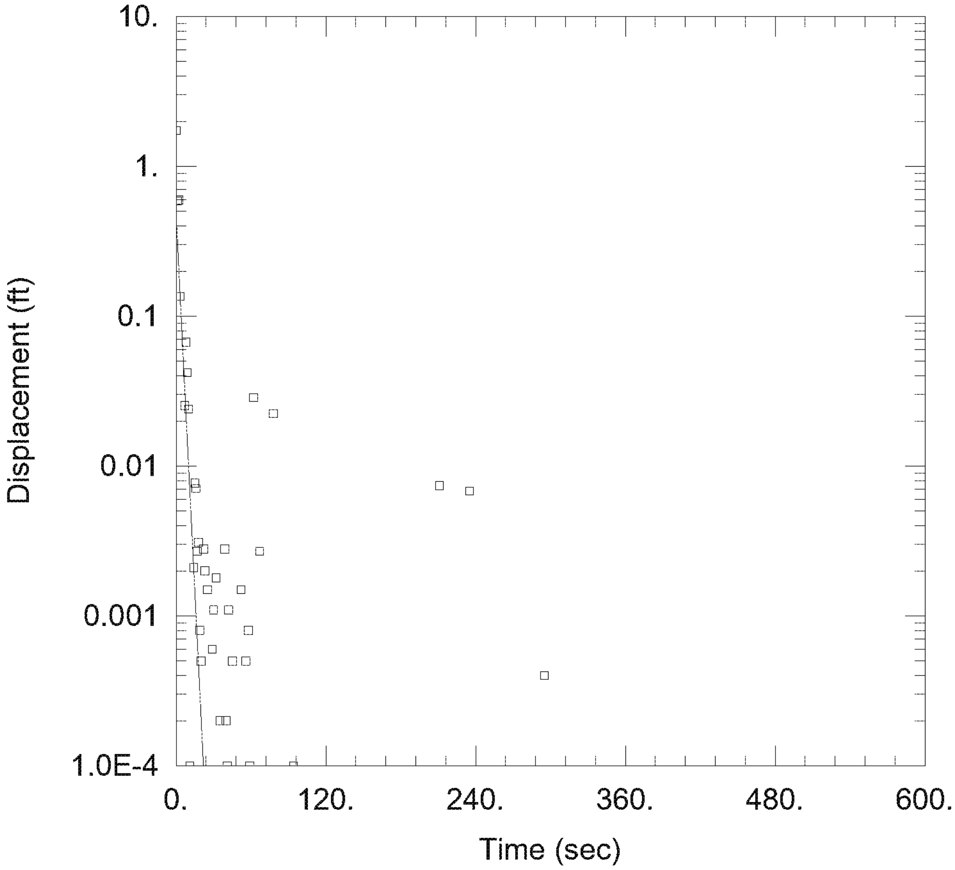
WELL DATA (WBSP-15-06)

Initial Displacement: 1.737 ft Static Water Column Height: 26.6 ft
Total Well Penetration Depth: 89. ft Screen Length: 10. ft
Casing Radius: 0.083 ft Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Confined Solution Method: Bouwer-Rice

K = 0.01605 cm/sec y0 = 0.4891 ft



OUT-A

Data Set: Y:\...\WBSP-15-06_OUT-A-H.aqt
Date: 08/19/16
Time: 14:38:52

PROJECT INFORMATION

Company: AGES, Inc.
Client: OVEC
Project: 2016002
Location: Clifty Creek Station
Test Well: WBSP-15-06
Test Date: 05/17/2016

AQUIFER DATA

Saturated Thickness: 40.81 ft
Anisotropy Ratio (Kz/Kr): 1.

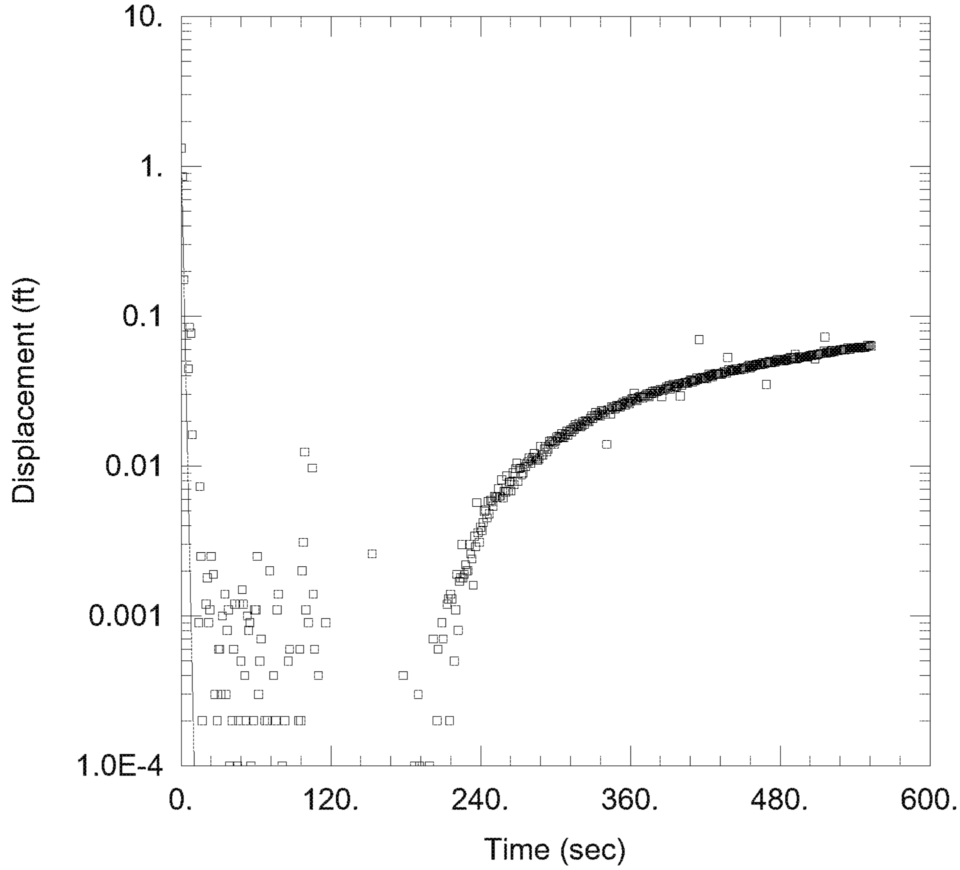
WELL DATA (WBSP-15-06)

Initial Displacement: 1.737 ft
Static Water Column Height: 26.6 ft
Total Well Penetration Depth: 89. ft
Screen Length: 10. ft
Casing Radius: 0.083 ft
Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Confined
Solution Method: Hvorslev

K = 0.01657 cm/sec
y0 = 0.4891 ft



OUT-B

Data Set: Y:\...\WBSP-15-06_OUT-B-BR.aqt
Date: 08/19/16
Time: 14:39:38

PROJECT INFORMATION

Company: AGES, Inc.
Client: OVEC
Project: 2016002
Location: Clifty Creek Station
Test Well: WBSP-15-06
Test Date: 05/17/2016

AQUIFER DATA

Saturated Thickness: 40.81 ft
Anisotropy Ratio (Kz/Kr): 1.

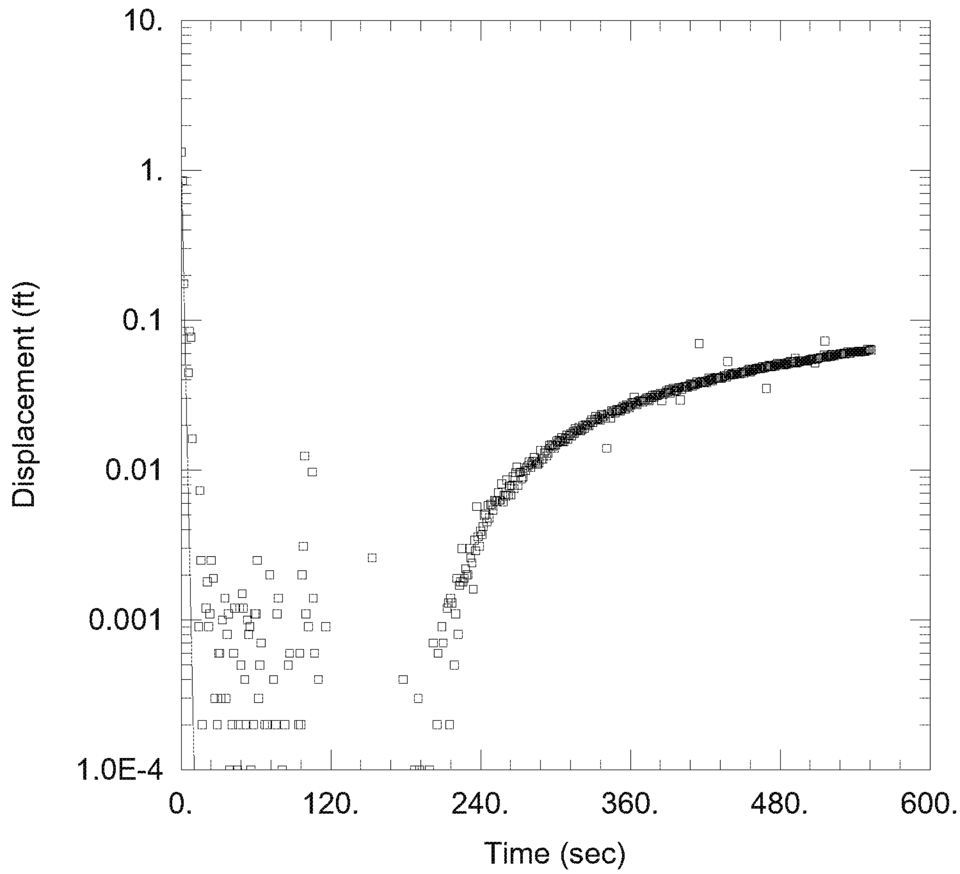
WELL DATA (WBSP-15-06)

Initial Displacement: 1.326 ft
Static Water Column Height: 26.66 ft
Total Well Penetration Depth: 89. ft
Screen Length: 10. ft
Casing Radius: 0.083 ft
Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice

K = 0.03628 cm/sec
y0 = 1.404 ft



OUT-B

Data Set: Y:\...\WBSP-15-06_OUT-B-H.aqt
Date: 08/19/16 Time: 14:40:26

PROJECT INFORMATION

Company: AGES, Inc.
Client: OVEC
Project: 2016002
Location: Clifty Creek Station
Test Well: WBSP-15-06
Test Date: 05/17/2016

AQUIFER DATA

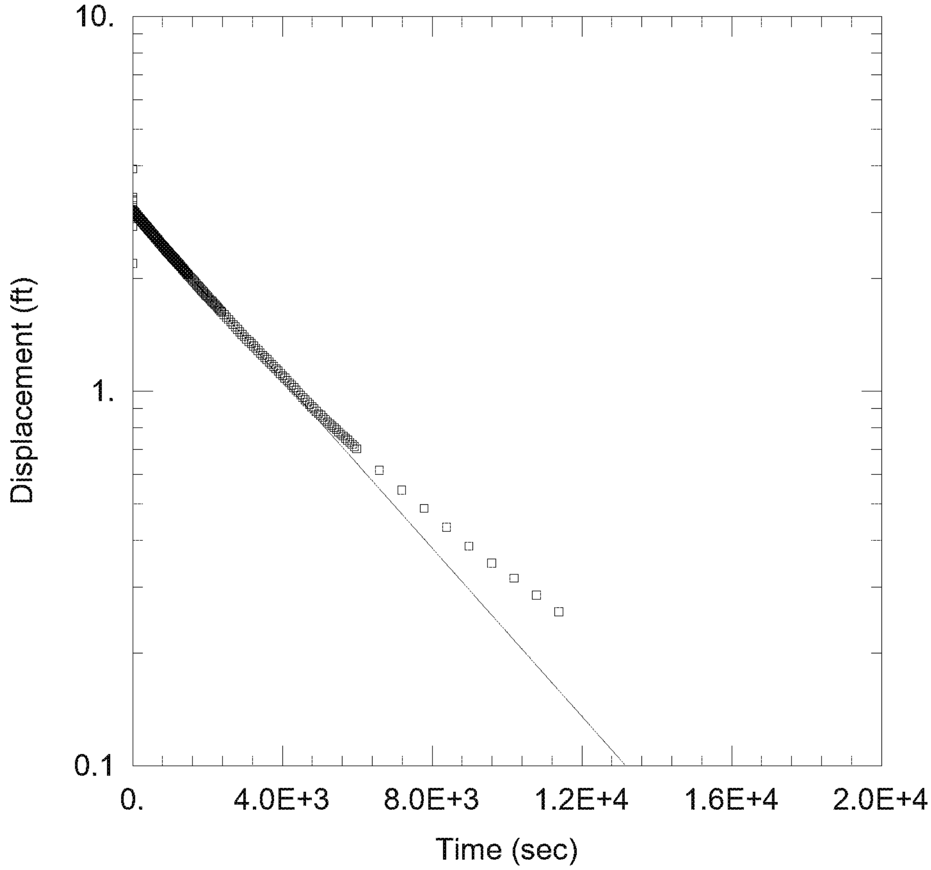
Saturated Thickness: 40.81 ft Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (WBSP-15-06)

Initial Displacement: 1.326 ft Static Water Column Height: 26.66 ft
Total Well Penetration Depth: 89. ft Screen Length: 10. ft
Casing Radius: 0.083 ft Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Confined Solution Method: Hvorslev
K = 0.03906 cm/sec y0 = 1.404 ft



IN-A

Data Set: Y:\...\WBSP-15-07_IN-A-BR.aqt
Date: 08/19/16 Time: 14:41:16

PROJECT INFORMATION

Company: AGES, Inc.
Client: OVEC
Project: 2016002
Location: Clifty Creek Station
Test Well: WBSP-15-07
Test Date: 05/17/2016

AQUIFER DATA

Saturated Thickness: 15.17 ft Anisotropy Ratio (Kz/Kr): 1.

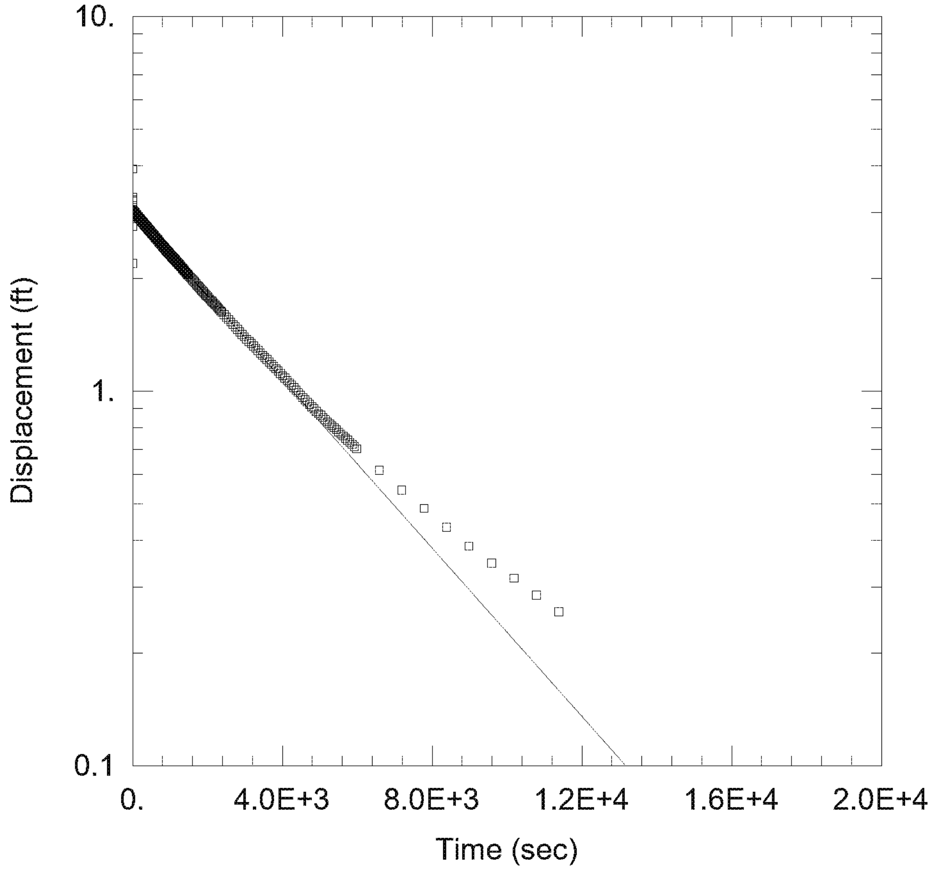
WELL DATA (WBSP-15-07)

Initial Displacement: 3.919 ft Static Water Column Height: 16.94 ft
Total Well Penetration Depth: 55. ft Screen Length: 10. ft
Casing Radius: 0.083 ft Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Confined Solution Method: Bouwer-Rice

K = 9.663E-6 cm/sec y0 = 3.024 ft



IN-A

Data Set: Y:\...\WBSP-15-07_IN-A-H.aqt
Date: 08/19/16 Time: 14:41:57

PROJECT INFORMATION

Company: AGES, Inc.
Client: OVEC
Project: 2016002
Location: Clifty Creek Station
Test Well: WBSP-15-07
Test Date: 05/17/2016

AQUIFER DATA

Saturated Thickness: 15.17 ft Anisotropy Ratio (Kz/Kr): 1.

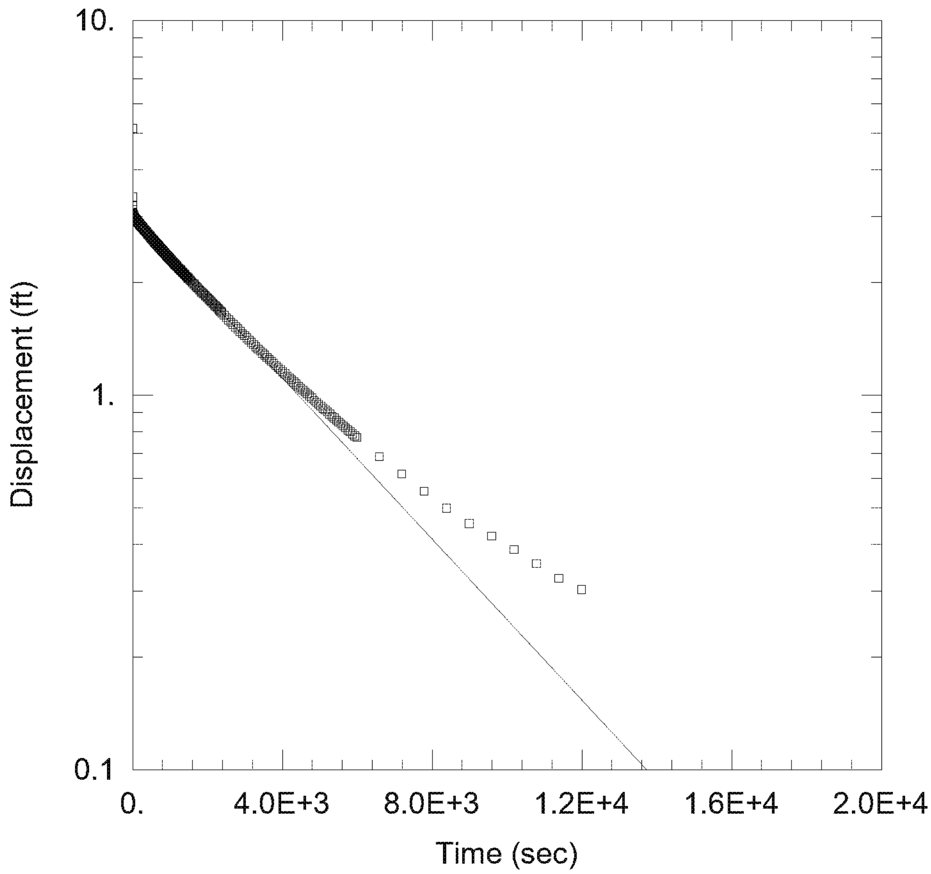
WELL DATA (WBSP-15-07)

Initial Displacement: 3.919 ft
Total Well Penetration Depth: 55. ft
Casing Radius: 0.083 ft
Static Water Column Height: 16.94 ft
Screen Length: 10. ft
Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Confined Solution Method: Hvorslev

K = 1.112E-5 cm/sec y0 = 3.024 ft



OUT-B

Data Set: Y:\...\WBSP-15-07_OUT-B-BR.aqt
Date: 08/19/16 Time: 14:42:48

PROJECT INFORMATION

Company: AGES, Inc.
Client: OVEC
Project: 2016002
Location: Clifty Creek Station
Test Well: WBSP-15-07
Test Date: 05/17/2016

AQUIFER DATA

Saturated Thickness: 15.17 ft Anisotropy Ratio (Kz/Kr): 1.

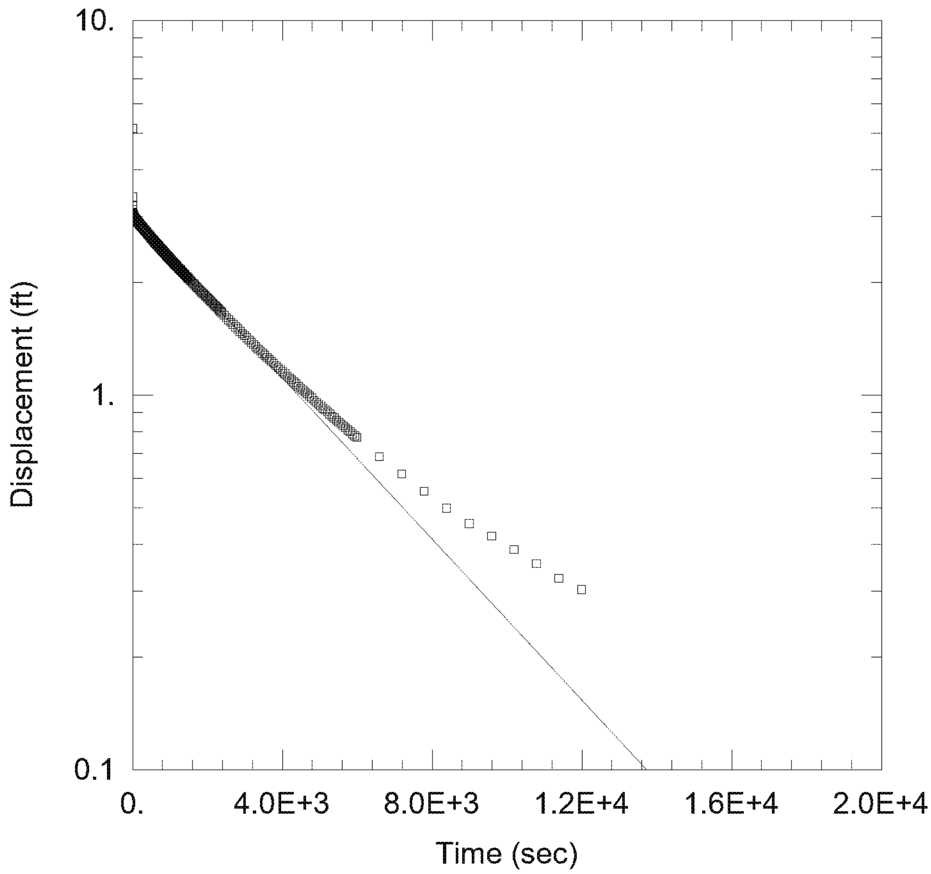
WELL DATA (WBSP-15-07)

Initial Displacement: 5.152 ft Static Water Column Height: 17.19 ft
Total Well Penetration Depth: 55. ft Screen Length: 10. ft
Casing Radius: 0.083 ft Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Confined Solution Method: Bouwer-Rice

K = 9.242E-6 cm/sec y0 = 2.992 ft



OUT-B

Data Set: Y:\...\WBSP-15-07_OUT-B-H.aqt
Date: 08/19/16 Time: 14:43:40

PROJECT INFORMATION

Company: AGES, Inc.
Client: OVEC
Project: 2016002
Location: Clifty Creek Station
Test Well: WBSP-15-07
Test Date: 05/17/2016

AQUIFER DATA

Saturated Thickness: 15.17 ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (WBSP-15-07)

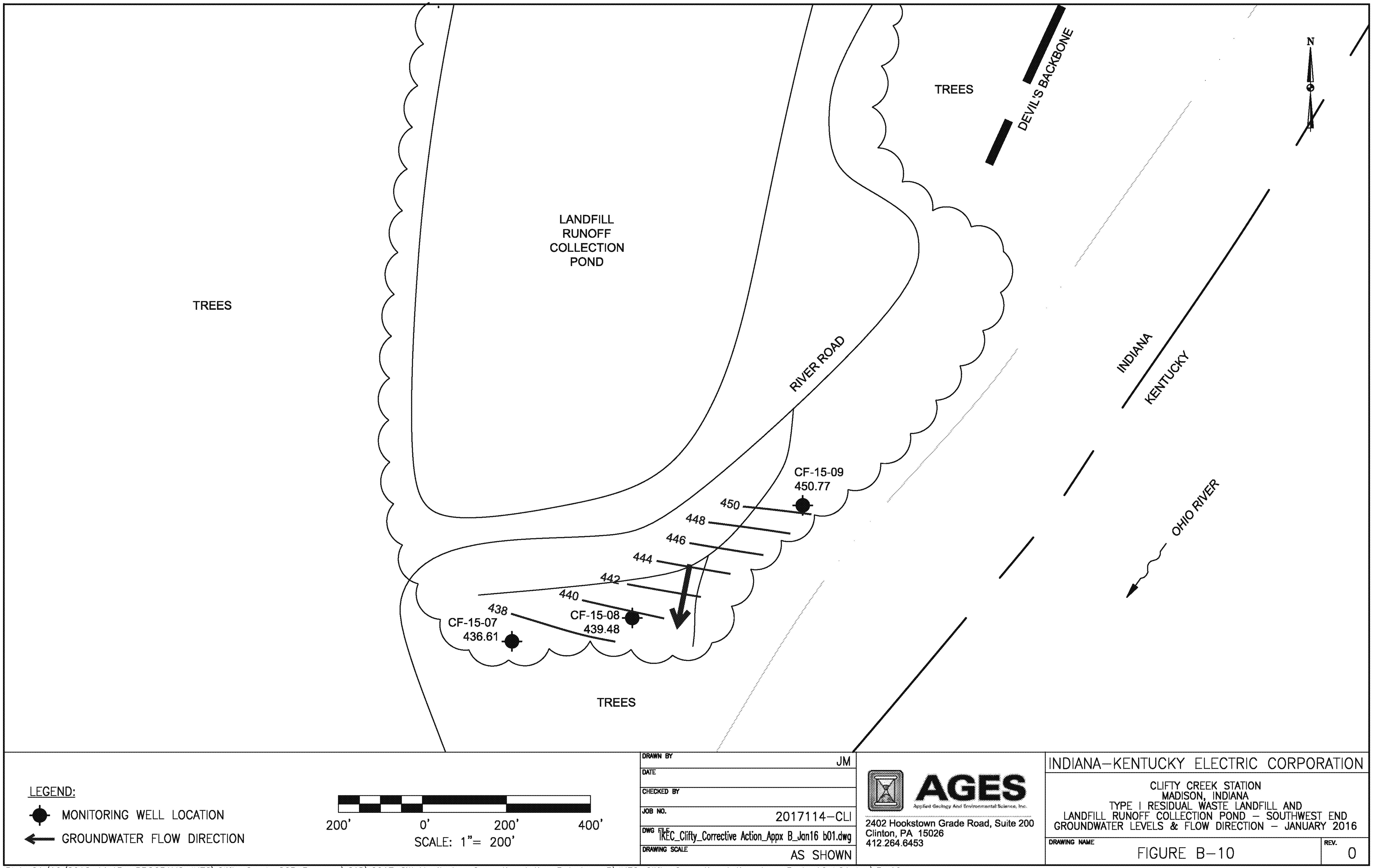
Initial Displacement: 5.152 ft
Total Well Penetration Depth: 55. ft
Casing Radius: 0.083 ft
Static Water Column Height: 17.19 ft
Screen Length: 10. ft
Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Confined
Solution Method: Hvorslev

K = 1.064E-5 cm/sec
y0 = 2.992 ft

APPENDIX E2 – GROUNDWATER CONTOUR MAPS



DRAWN BY	JM
DATE	
CHECKED BY	
JOB NO.	2017114-CLI
DWG FILE	IKEC_Clifty_Corrective Action_Appx B_Jan16 b01.dwg
DRAWING SCALE	AS SHOWN

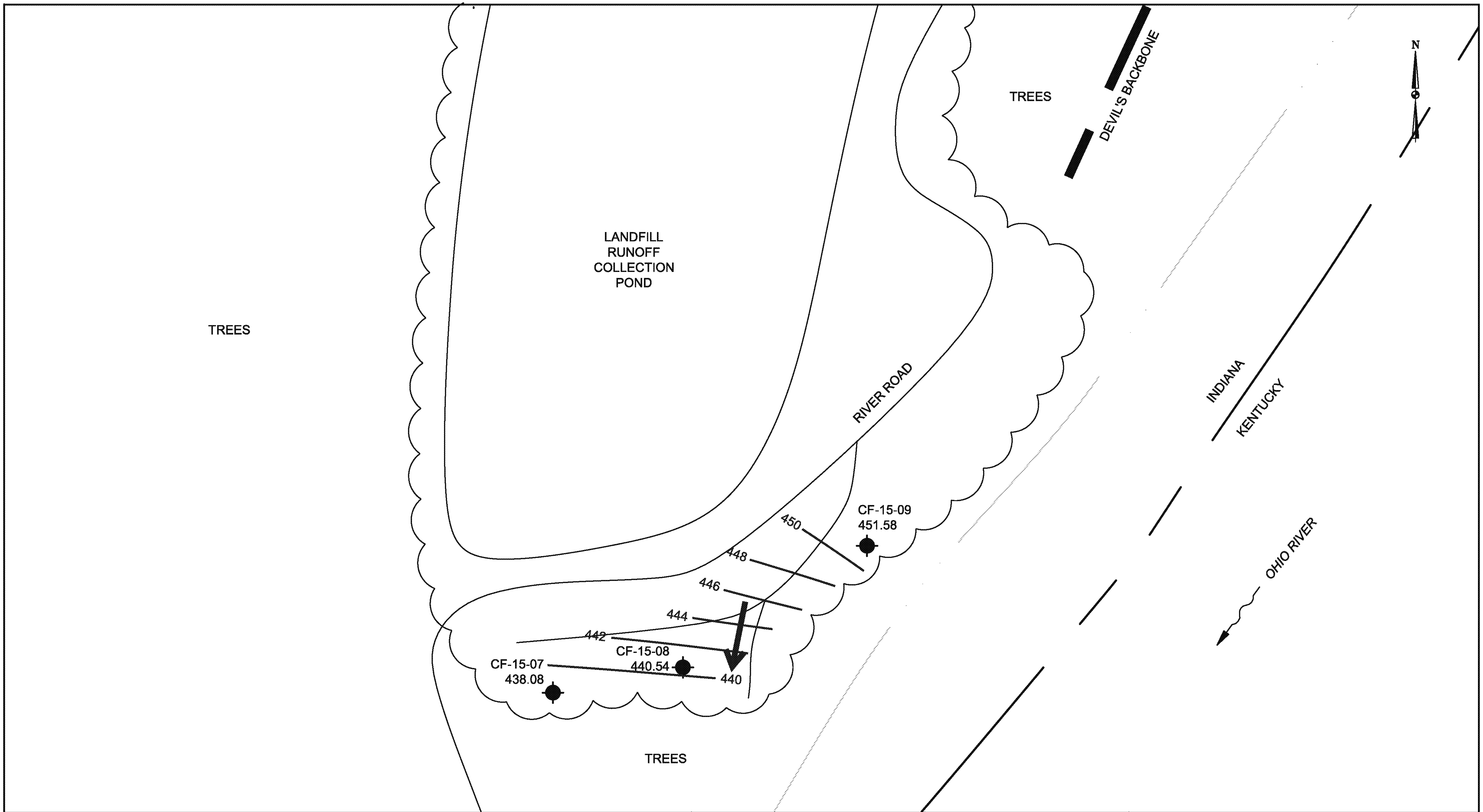
AGES
Applied Geology And Environmental Science, Inc.
2402 Hookstown Grade Road, Suite 200
Clinton, PA 15026
412.264.6453

INDIANA–KENTUCKY ELECTRIC CORPORATION

CLIFTY CREEK STATION
MADISON, INDIANA
TYPE I RESIDUAL WASTE LANDFILL AND
LANDFILL RUNOFF COLLECTION POND – SOUTHWEST END
GROUNDWATER LEVELS & FLOW DIRECTION – JANUARY 2016

DRAWING NAME: FIGURE B–10 | REV. 0

Plot: 01/16/2018 11:43 _PROGRAMS–IKEC\Clifty Creek–CCR Program\CAD\2017 GW Monitoring–Corrective Action Rpt–Appx B\IKEC_Clifty_Corrective Action_Appx B_Jan16 b01.dwg\B–10



LEGEND:

MONITORING WELL LOCATION

GROUNDWATER FLOW DIRECTION

200' 0' 200' 400'

SCALE: 1"= 200'

DRAWN BY	JM
DATE	
CHECKED BY	
JOB NO.	2017114-CLI
DWG FILE	IKEC_Clifty_Corrective Action_Appx B_Mar16 b02.dwg
DRAWING SCALE	AS SHOWN

AGES

Applied Geology And Environmental Science, Inc.

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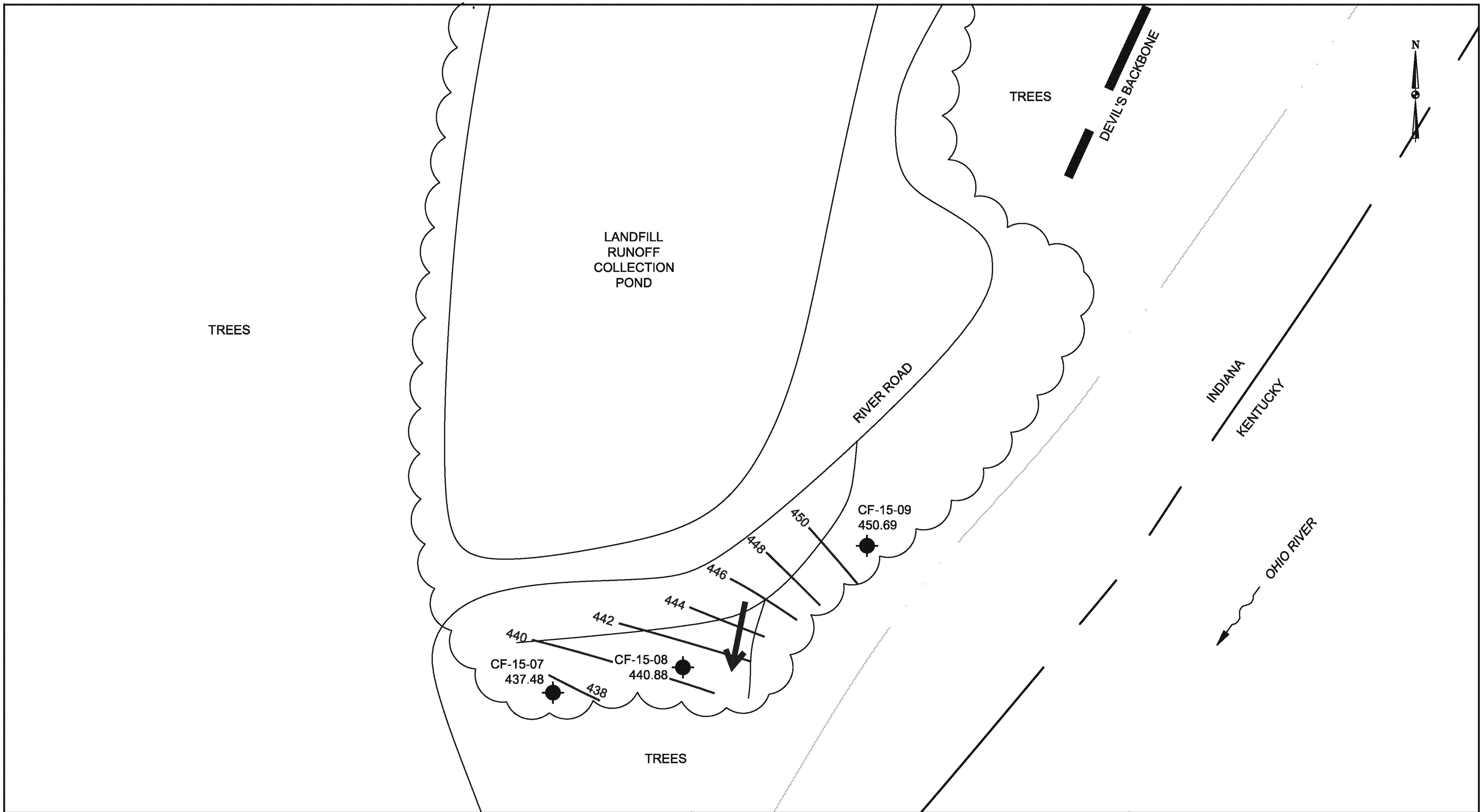
INDIANA–KENTUCKY ELECTRIC CORPORATION

CLIFTY CREEK STATION
MADISON, INDIANA
TYPE I RESIDUAL WASTE LANDFILL AND
LANDFILL RUNOFF COLLECTION POND – SOUTHWEST END
GROUNDWATER LEVELS & FLOW DIRECTION – MARCH 2016

DRAWING NAME: FIGURE B–11

REV. 0

Plot: 01/16/2018 14:13 _PROGRAMS–IKEC\Clifty Creek–CCR Program\CAD\2017 GW Monitoring–Corrective Action Rpt–Appx B\IKEC_Clifty_Corrective Action_Appx B_Mar16 b02.dwg\B–11



LEGEND:

MONITORING WELL LOCATION

GROUNDWATER FLOW DIRECTION

200' 0' 200' 400'

SCALE: 1"= 200'

DRAWN BY	JM
DATE	
CHECKED BY	
JOB NO.	2017114-CLI
DWG FILE	IKEC_Clifty_Corrective Action_Appx B_May16 b03.dwg
DRAWING SCALE	AS SHOWN

AGES
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Clinton, PA 15026
412.264.6453

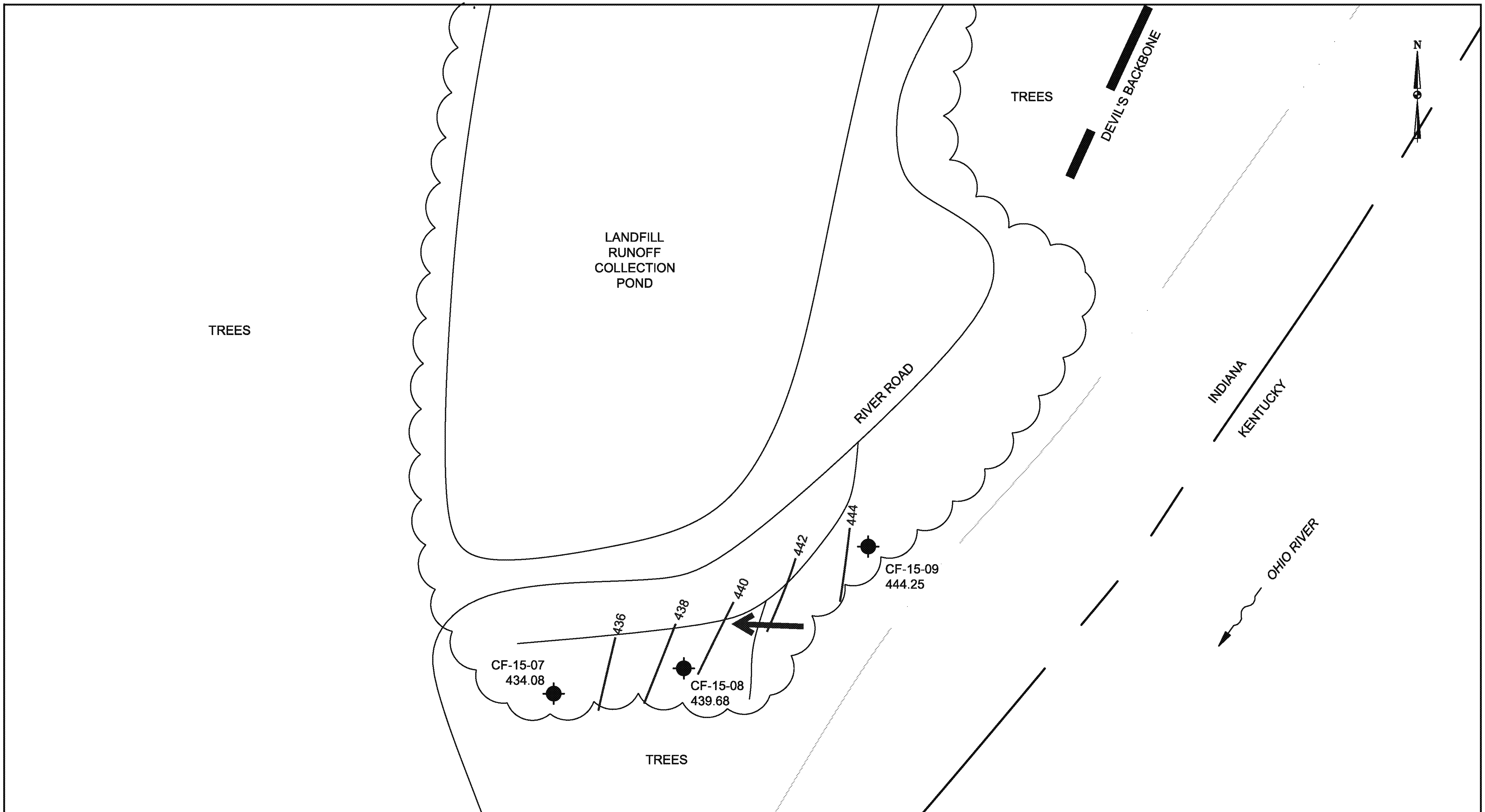
INDIANA–KENTUCKY ELECTRIC CORPORATION

CLIFTY CREEK STATION
MADISON, INDIANA
TYPE I RESIDUAL WASTE LANDFILL AND
LANDFILL RUNOFF COLLECTION POND – SOUTHWEST END
GROUNDWATER LEVELS & FLOW DIRECTION – MAY 2016

DRAWING NAME: FIGURE B–12

REV. 0

Plot: 01/16/2018 15:26 _PROGRAMS–IKEC\Clifty Creek–CCR Program\CAD\2017 GW Monitoring–Corrective Action Rpt–Appx B\IKEC_Clifty_Corrective Action_Appx B_May16 b03.dwg\B–12



LEGEND:

- MONITORING WELL LOCATION
- GROUNDWATER FLOW DIRECTION

200' 0' 200' 400'

SCALE: 1"= 200'

DRAWN BY	JM
DATE	
CHECKED BY	
JOB NO.	2017114-CLI
DWG FILE	IKEC_Clifty_Corrective Action_Appx B_July16 b04.dwg
DRAWING SCALE	AS SHOWN

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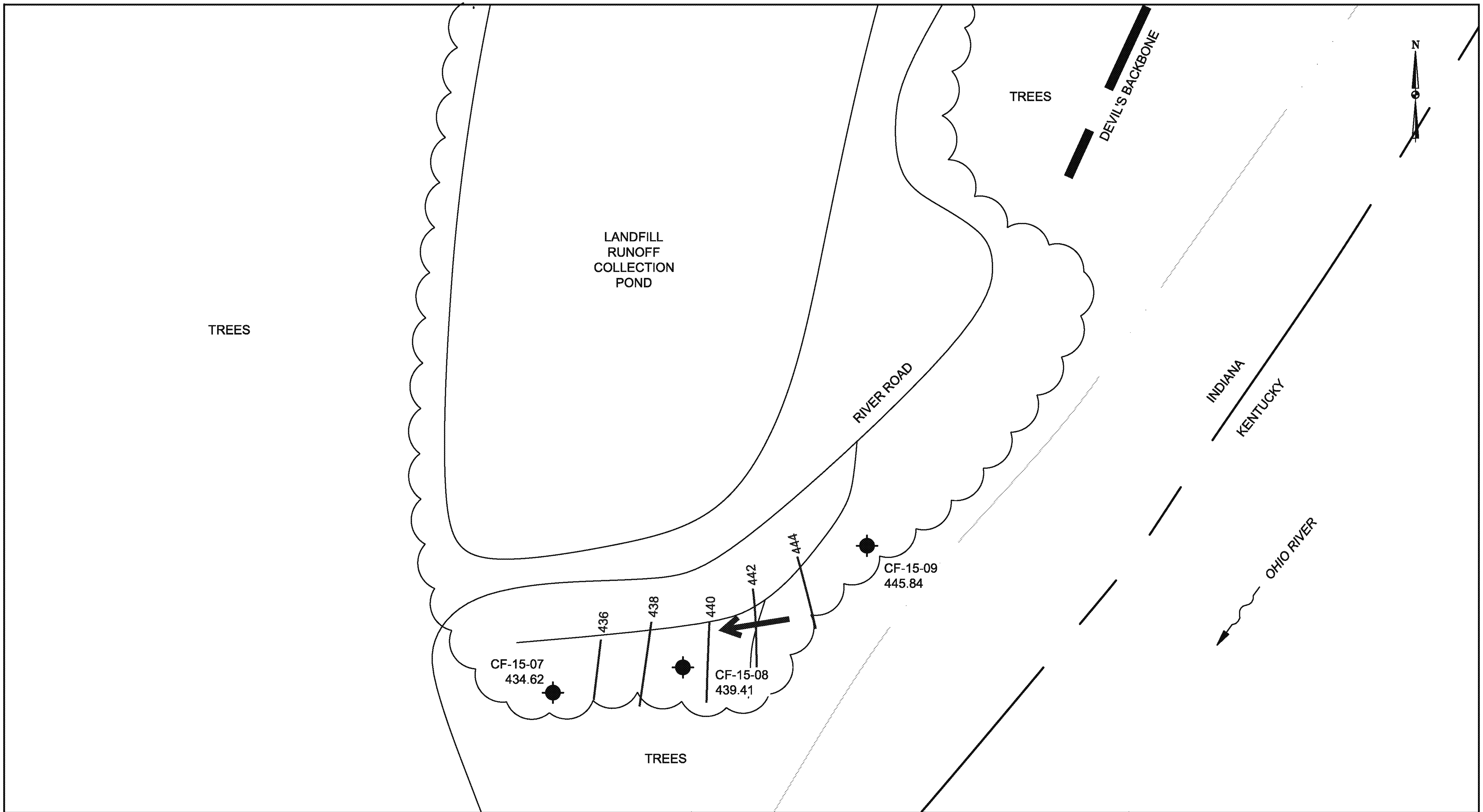
CLIFTY CREEK STATION
MADISON, INDIANA
TYPE I RESIDUAL WASTE LANDFILL AND
LANDFILL RUNOFF COLLECTION POND – SOUTHWEST END
GROUNDWATER LEVELS & FLOW DIRECTION – JULY 2016

DRAWING NAME: FIGURE B–13
REV. 0

Plot: 01/17/2018 10:59 _PROGRAMS–IKEC\Clifty Creek–CCR Program\CAD\2017 GW Monitoring–Corrective Action Rpt–Appx B\IKEC_Clifty_Corrective Action_Appx B_July16 b04.dwg\B–13



LEGEND:

- MONITORING WELL LOCATION
- GROUNDWATER FLOW DIRECTION

200' 0' 200' 400'

SCALE: 1"= 200'

DRAWN BY	JM
DATE	
CHECKED BY	
JOB NO.	2017114-CLI
DWG FILE	IKEC_Clifty_Corrective Action_Appx B_Aug16 b05.dwg
DRAWING SCALE	AS SHOWN

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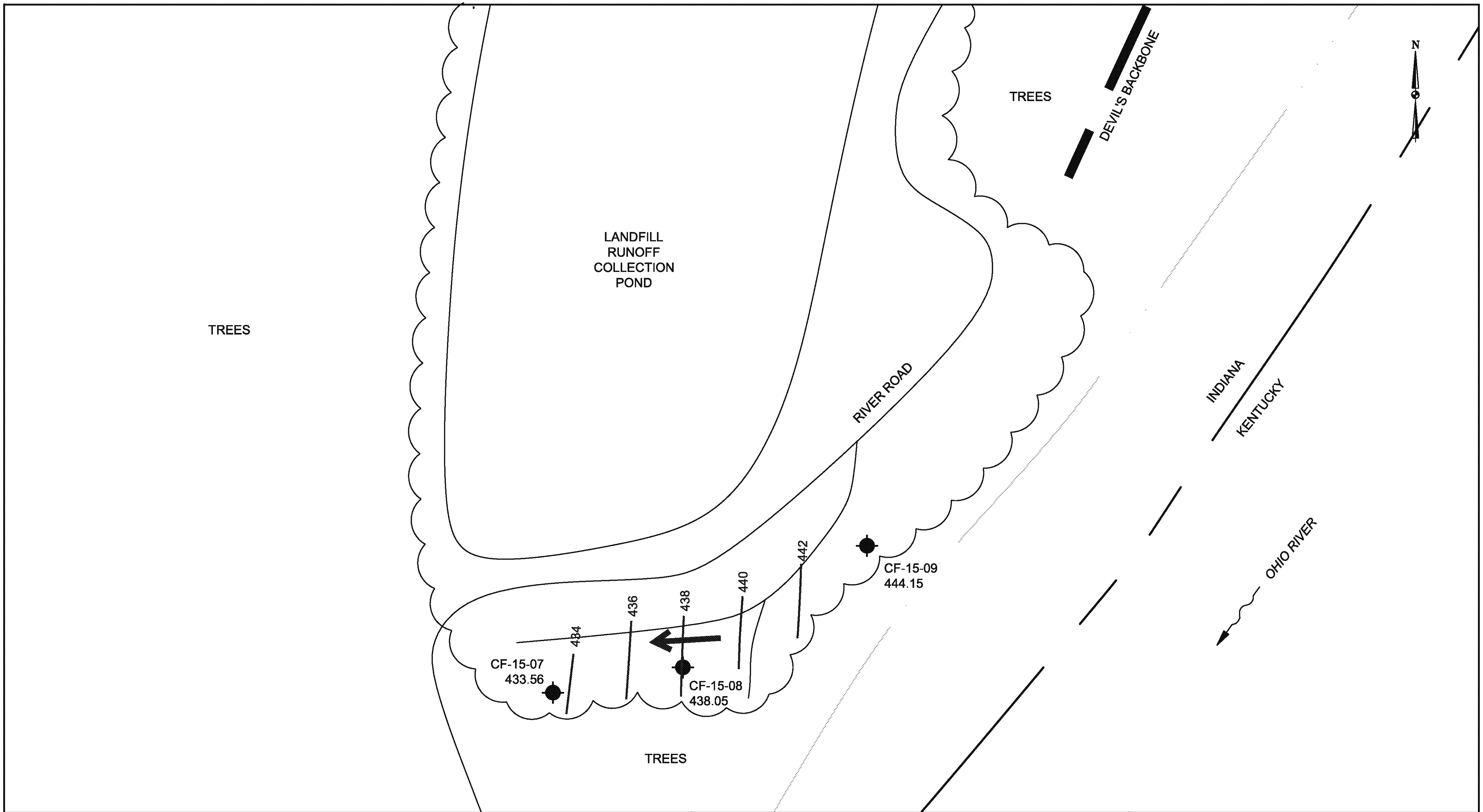
MADISON, INDIANA
TYPE I RESIDUAL WASTE LANDFILL AND
LANDFILL RUNOFF COLLECTION POND – SOUTHWEST END
GROUNDWATER LEVELS & FLOW DIRECTION – AUGUST 2016

DRAWING NAME: FIGURE B–14

REV. 0

Plot: 01/17/2018 16:15 _PROGRAMS–IKEC\Clifty Creek–CCR Program\CAD\2017 GW Monitoring–Corrective Action Rpt–Appx B\IKEC_Clifty_Corrective Action_Appx B_Aug16 b05.dwg\B–14



LEGEND:
- MONITORING WELL LOCATION
- GROUNDWATER FLOW DIRECTION

200' 0' 200' 400'
SCALE: 1"= 200'

DRAWN BY	JM
DATE	
CHECKED BY	
JOB NO.	2017114–CLI
DWG FILE	IKEC_Clifty_Corrective Action_Appx B_Nov16 b06.dwg
DRAWING SCALE	AS SHOWN

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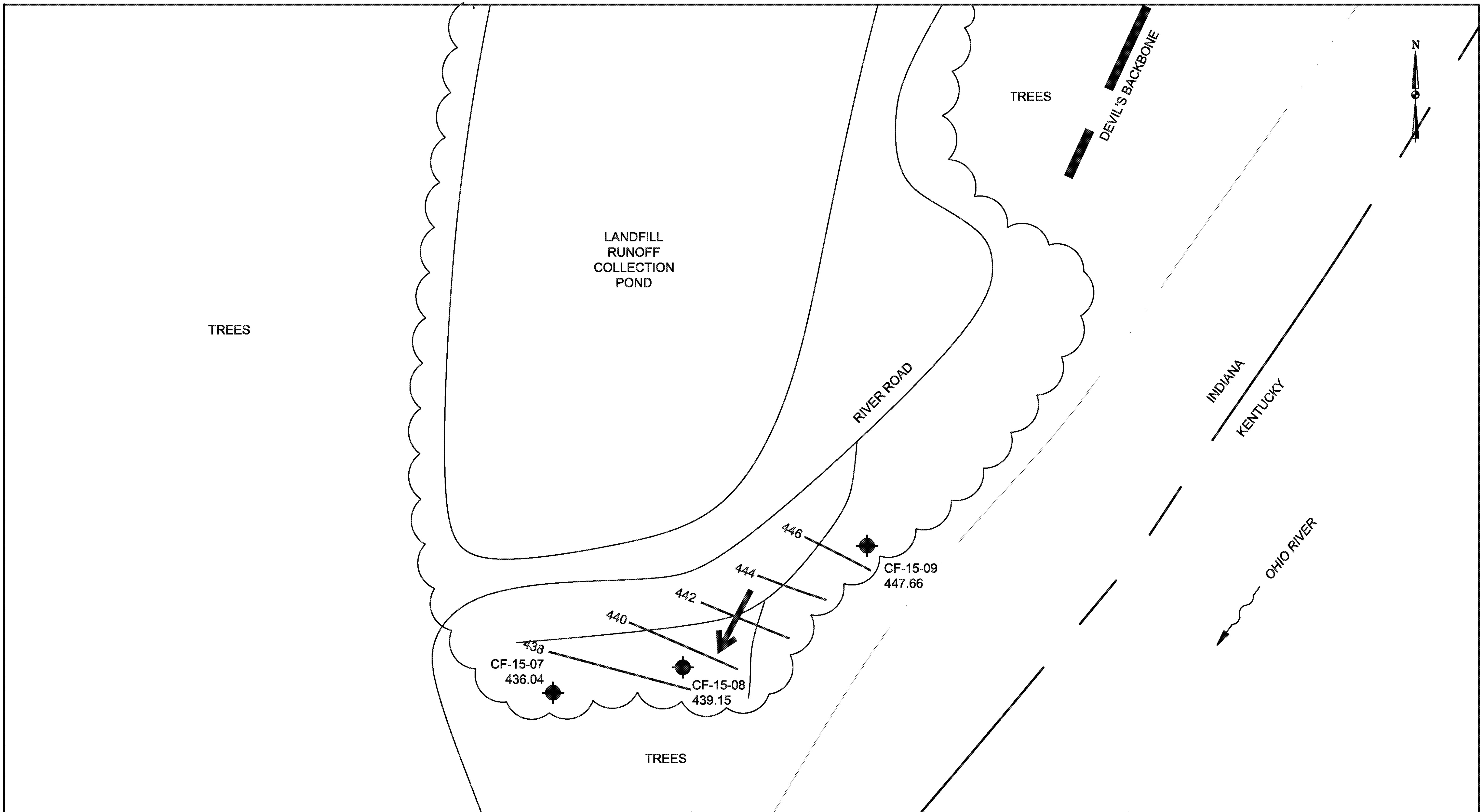
MADISON, INDIANA
TYPE I RESIDUAL WASTE LANDFILL AND
LANDFILL RUNOFF COLLECTION POND – SOUTHWEST END
GROUNDWATER LEVELS & FLOW DIRECTION – NOVEMBER 2016

DRAWING NAME: FIGURE B–15
REV. 0

Plot: 01/18/2018 11:38 _PROGRAMS–IKEC\Clifty Creek–CCR Program\CAD\2017 GW Monitoring–Corrective Action Rpt–Appx B\IKEC_Clifty_Corrective Action_Appx B_Nov16 b06.dwg\B–15



LEGEND:
- MONITORING WELL LOCATION
- GROUNDWATER FLOW DIRECTION

200' 0' 200' 400'
SCALE: 1"= 200'

DRAWN BY	JM
DATE	
CHECKED BY	
JOB NO.	2017114–CLI
DWG FILE	IKEC_Clifty_Corrective Action_Appx B_Feb17 b07.dwg
DRAWING SCALE	AS SHOWN

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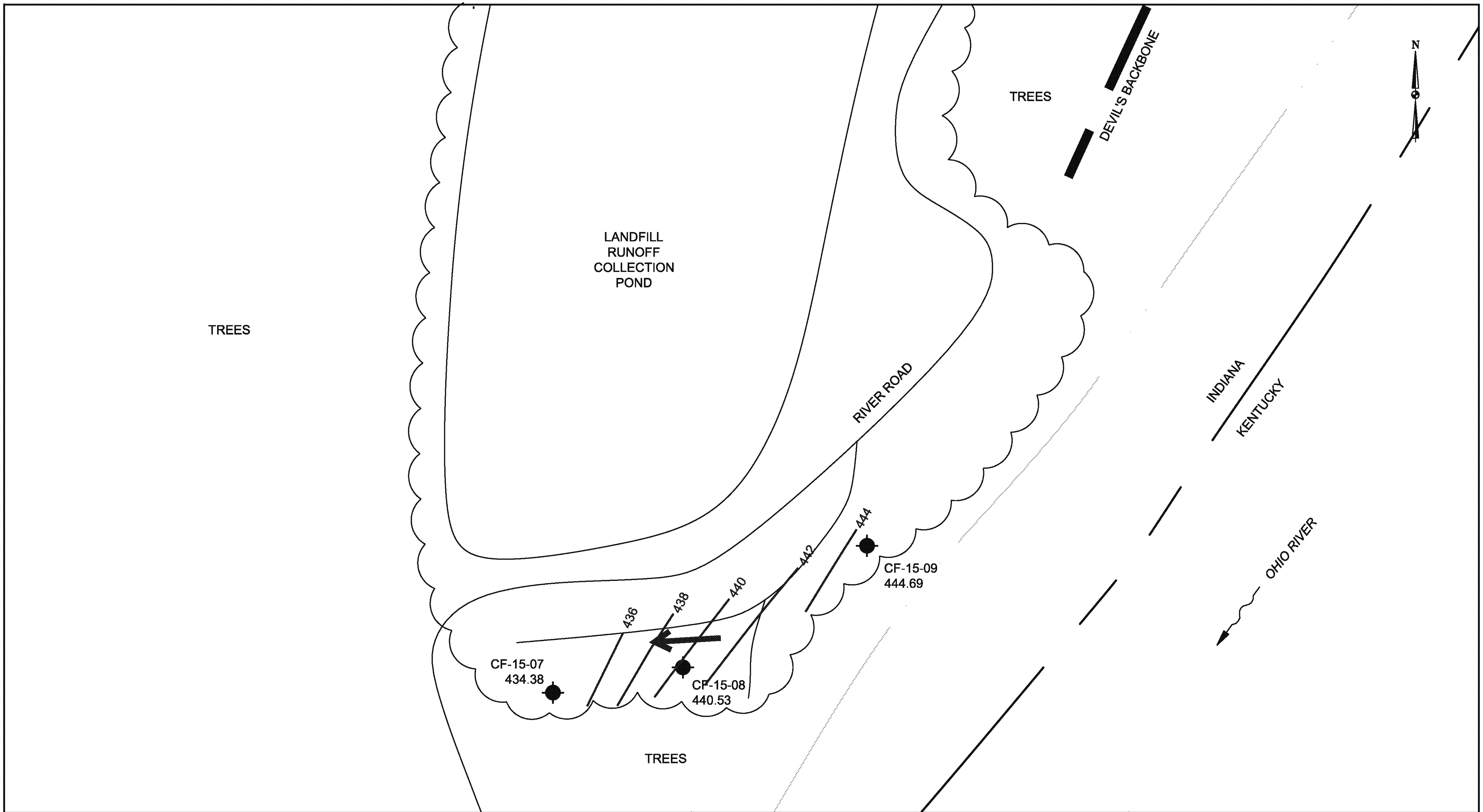
CLIFTY CREEK STATION
MADISON, INDIANA
TYPE I RESIDUAL WASTE LANDFILL AND
LANDFILL RUNOFF COLLECTION POND – SOUTHWEST END
GROUNDWATER LEVELS & FLOW DIRECTION – FEBRUARY 2017

DRAWING NAME: FIGURE B–16
REV. 0

Plot: 01/18/2018 14:38 _PROGRAMS–IKEC\Clifty Creek–CCR Program\CAD\2017 GW Monitoring–Corrective Action Rpt–Appx B\IKEC_Clifty_Corrective Action_Appx B_Feb17 b07.dwg\B–16



LEGEND:
MONITORING WELL LOCATION
GROUNDWATER FLOW DIRECTION

200' 0' 200' 400'
SCALE: 1"= 200'

DRAWN BY	JM
DATE	
CHECKED BY	
JOB NO.	2017114-CLI
DWG FILE	IKEC_Clifty_Corrective Action_Appx B_Jun17 b08.dwg
DRAWING SCALE	AS SHOWN

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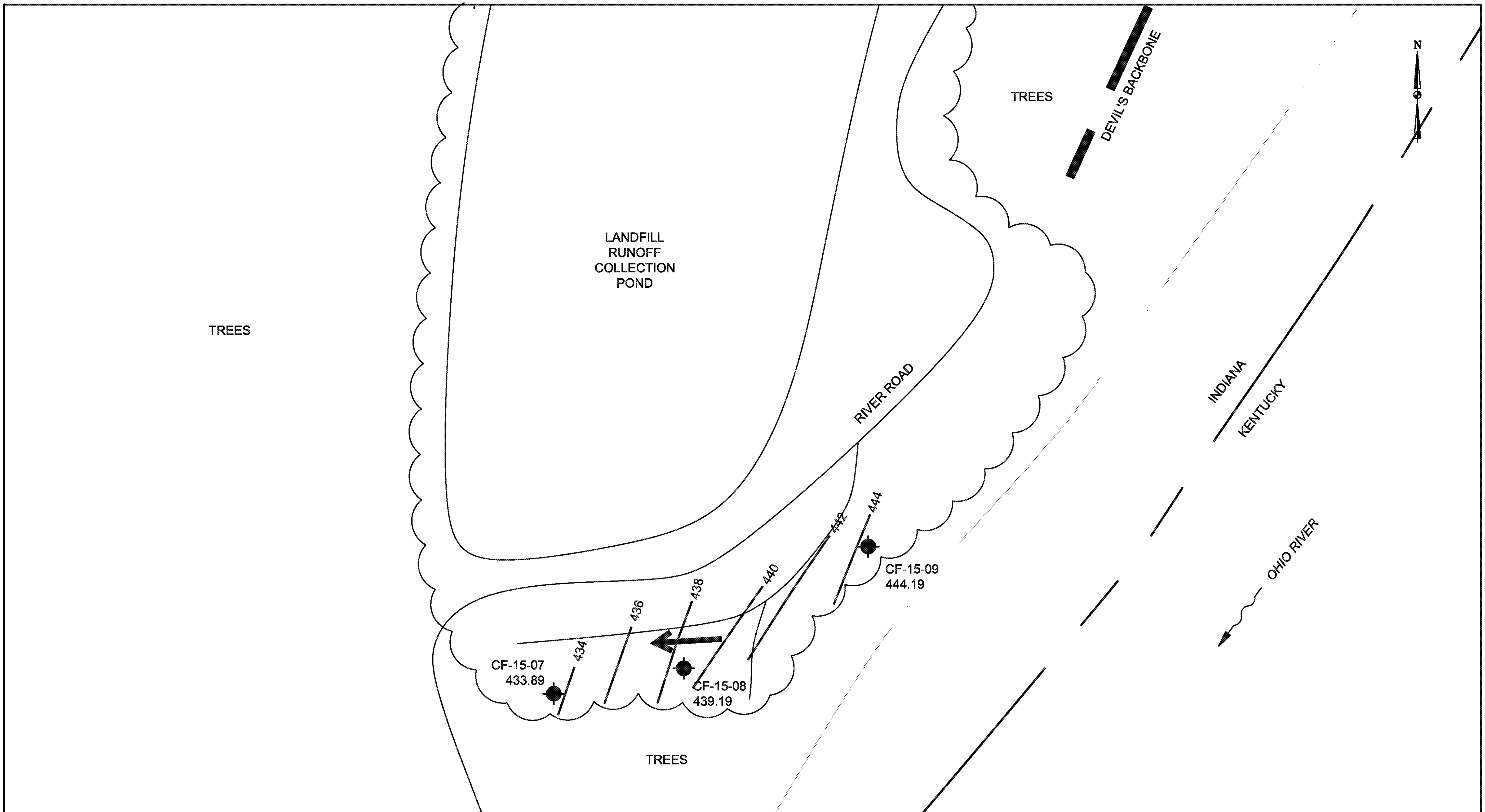
CLIFTY CREEK STATION
MADISON, INDIANA
TYPE I RESIDUAL WASTE LANDFILL AND
LANDFILL RUNOFF COLLECTION POND – SOUTHWEST END
GROUNDWATER LEVELS & FLOW DIRECTION – JUNE 2017

DRAWING NAME: FIGURE B–17
REV. 0

Plot: 01/18/2018 15:46 _PROGRAMS–IKEC\Clifty Creek–CCR Program\CAD\2017 GW Monitoring–Corrective Action Rpt–Appx B\IKEC_Clifty_Corrective Action_Appx B_Jun17 b08.dwg\B–17



LEGEND:

- MONITORING WELL LOCATION
- GROUNDWATER FLOW DIRECTION

200' 0' 200' 400'

SCALE: 1"= 200'

DRAWN BY	JM
DATE	
CHECKED BY	
JOB NO.	2017114–CLI
DWG FILE	IKEC_Clifty_Corrective Action_Appx B_Aug17 b09.dwg
DRAWING SCALE	AS SHOWN

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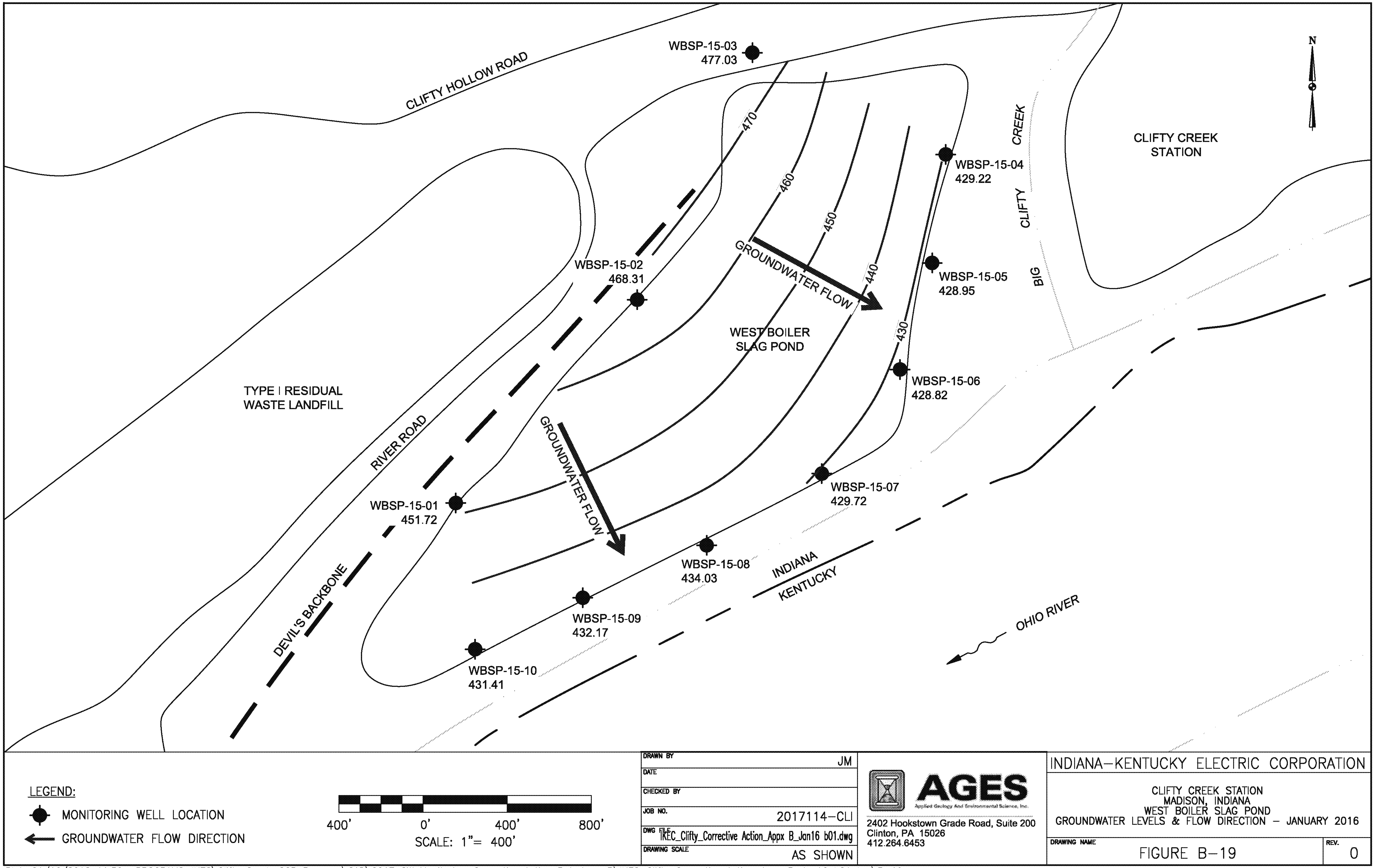
MADISON, INDIANA
TYPE I RESIDUAL WASTE LANDFILL AND
LANDFILL RUNOFF COLLECTION POND – SOUTHWEST END
GROUNDWATER LEVELS & FLOW DIRECTION – AUGUST 2017

DRAWING NAME: FIGURE B–18

REV. 0

Plot: 01/19/2018 15:08 _PROGRAMS–IKEC\Clifty Creek–CCR Program\CAD\2017 GW Monitoring–Corrective Action Rpt–Appx B\IKEC_Clifty_Corrective Action_Appx B_Aug17 b09.dwg\B–18



DRAWN BY	JM
DATE	
CHECKED BY	
JOB NO.	2017114–CLI
DWG FILE	IKEC_Clifty_Corrective Action_Appx B_Jan16 b01.dwg
DRAWING SCALE	AS SHOWN

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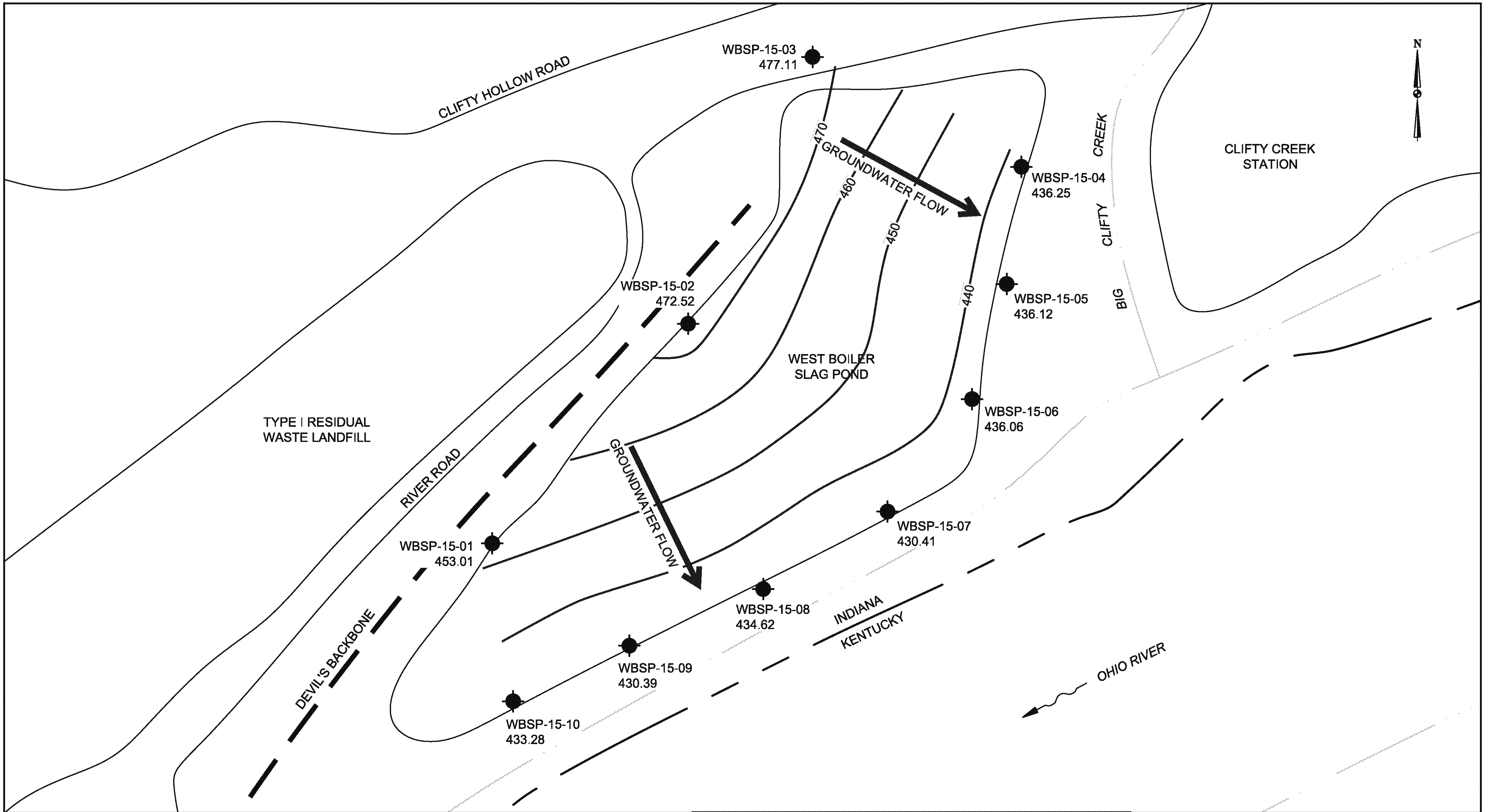
CLIFTY CREEK STATION
MADISON, INDIANA
WEST BOILER SLAG POND
GROUNDWATER LEVELS & FLOW DIRECTION – JANUARY 2016

DRAWING NAME: FIGURE B–19

REV. 0

Plot: 01/16/2018 11:50 _PROGRAMS–IKEC\Clifty Creek–CCR Program\CAD\2017 GW Monitoring–Corrective Action Rpt–Appx B\IKEC_Clifty_Corrective Action_Appx B_Jan16 b01.dwg\B–19



LEGEND:

- MONITORING WELL LOCATION
- GROUNDWATER FLOW DIRECTION

400' 0' 400' 800'

SCALE: 1"= 400'

DRAWN BY	JM
DATE	
CHECKED BY	
JOB NO.	2017114–CLI
DWG FILE	IKEC_Clifty_Corrective Action_Appx B_Mar16 b02.dwg
DRAWING SCALE	AS SHOWN

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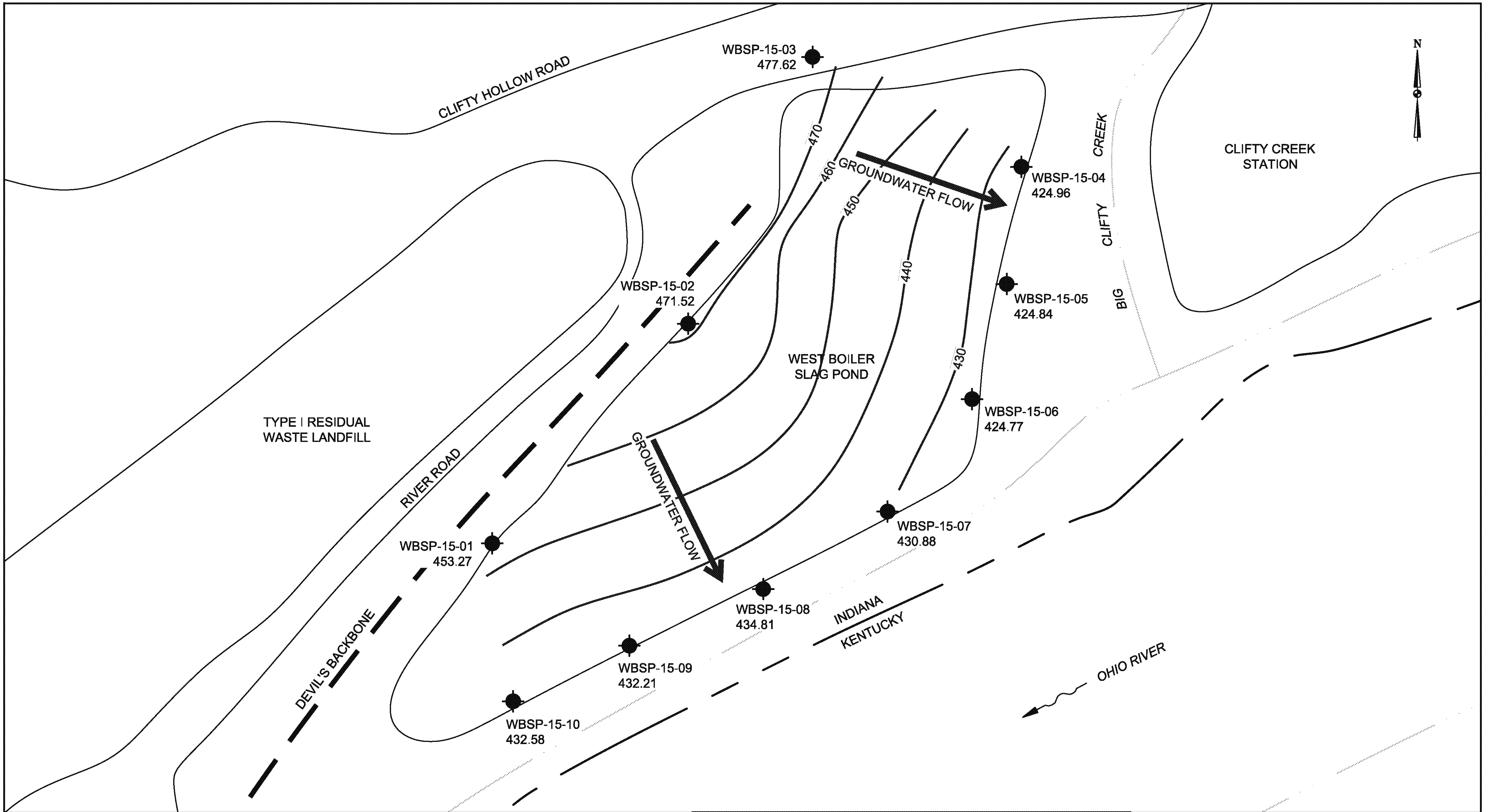
INDIANA–KENTUCKY ELECTRIC CORPORATION

CLIFTY CREEK STATION
MADISON, INDIANA
WEST BOILER SLAG POND
GROUNDWATER LEVELS & FLOW DIRECTION – MARCH 2016

DRAWING NAME: FIGURE B–20

REV. 0

Plot: 01/16/2018 14:21 _PROGRAMS–IKEC\Clifty Creek–CCR Program\CAD\2017 GW Monitoring–Corrective Action Rpt–Appx B\IKEC_Clifty_Corrective Action_Appx B_Mar16 b02.dwg\B–20



LEGEND:

- MONITORING WELL LOCATION
- GROUNDWATER FLOW DIRECTION

400' 0' 400' 800'

SCALE: 1"= 400'

DRAWN BY	JM
DATE	
CHECKED BY	
JOB NO.	2017114–CLI
DWG FILE	IKEC_Clifty_Corrective Action_Appx B_May16 b03.dwg
DRAWING SCALE	AS SHOWN

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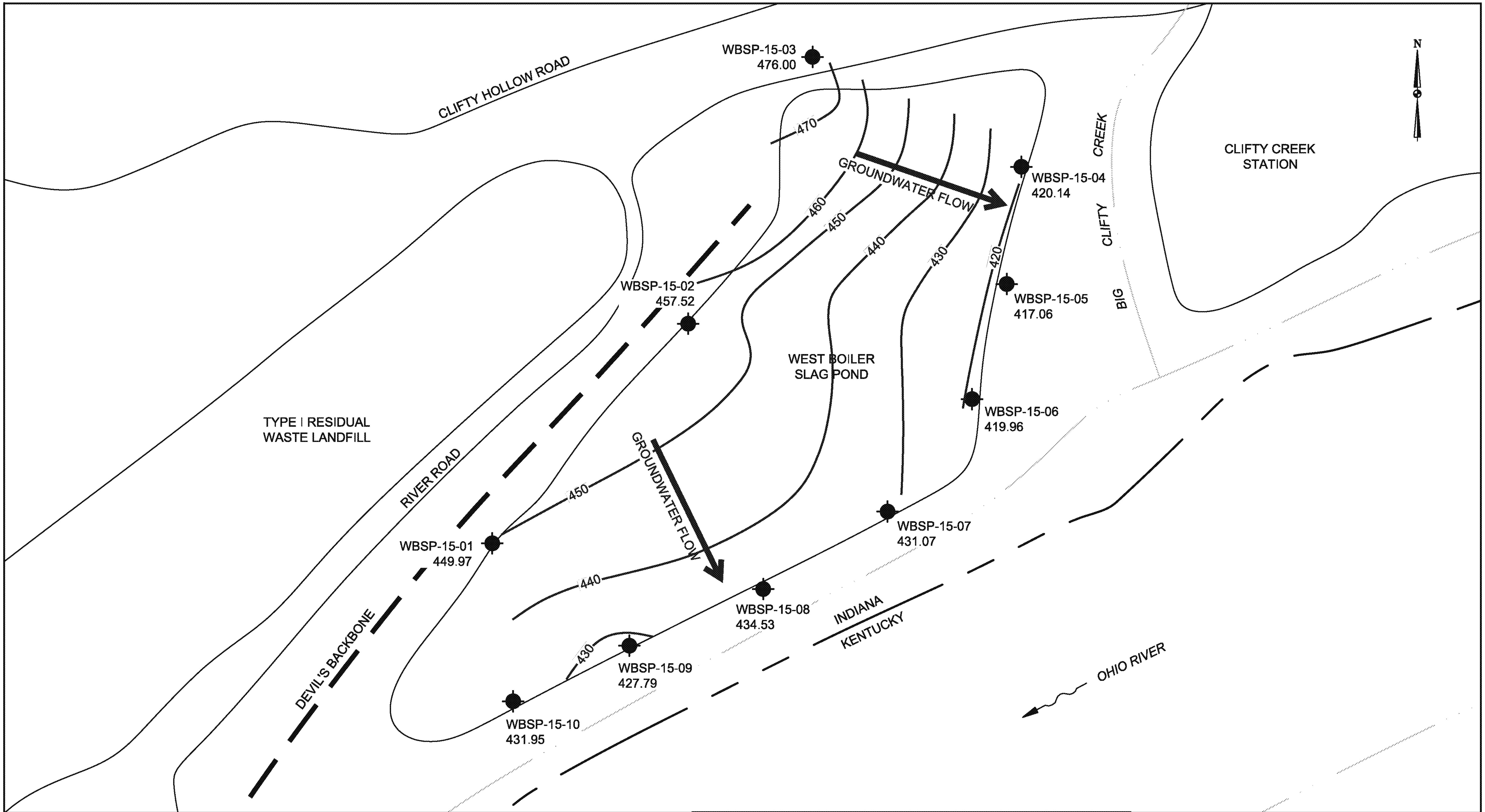
CLIFTY CREEK STATION
MADISON, INDIANA
WEST BOILER SLAG POND
GROUNDWATER LEVELS & FLOW DIRECTION – MAY 2016

DRAWING NAME: FIGURE B–21

REV. 0

Plot: 01/16/2018 15:32 _PROGRAMS–IKEC\Clifty Creek–CCR Program\CAD\2017 GW Monitoring–Corrective Action Rpt–Appx B\IKEC_Clifty_Corrective Action_Appx B_May16 b03.dwg\B–21



LEGEND:

- MONITORING WELL LOCATION
- GROUNDWATER FLOW DIRECTION

400' 0' 400' 800'

SCALE: 1"= 400'

DRAWN BY	JM
DATE	
CHECKED BY	
JOB NO.	2017114–CLI
DWG FILE	IKEC_Clifty_Corrective Action_Appx B_July16 b04.dwg
DRAWING SCALE	AS SHOWN

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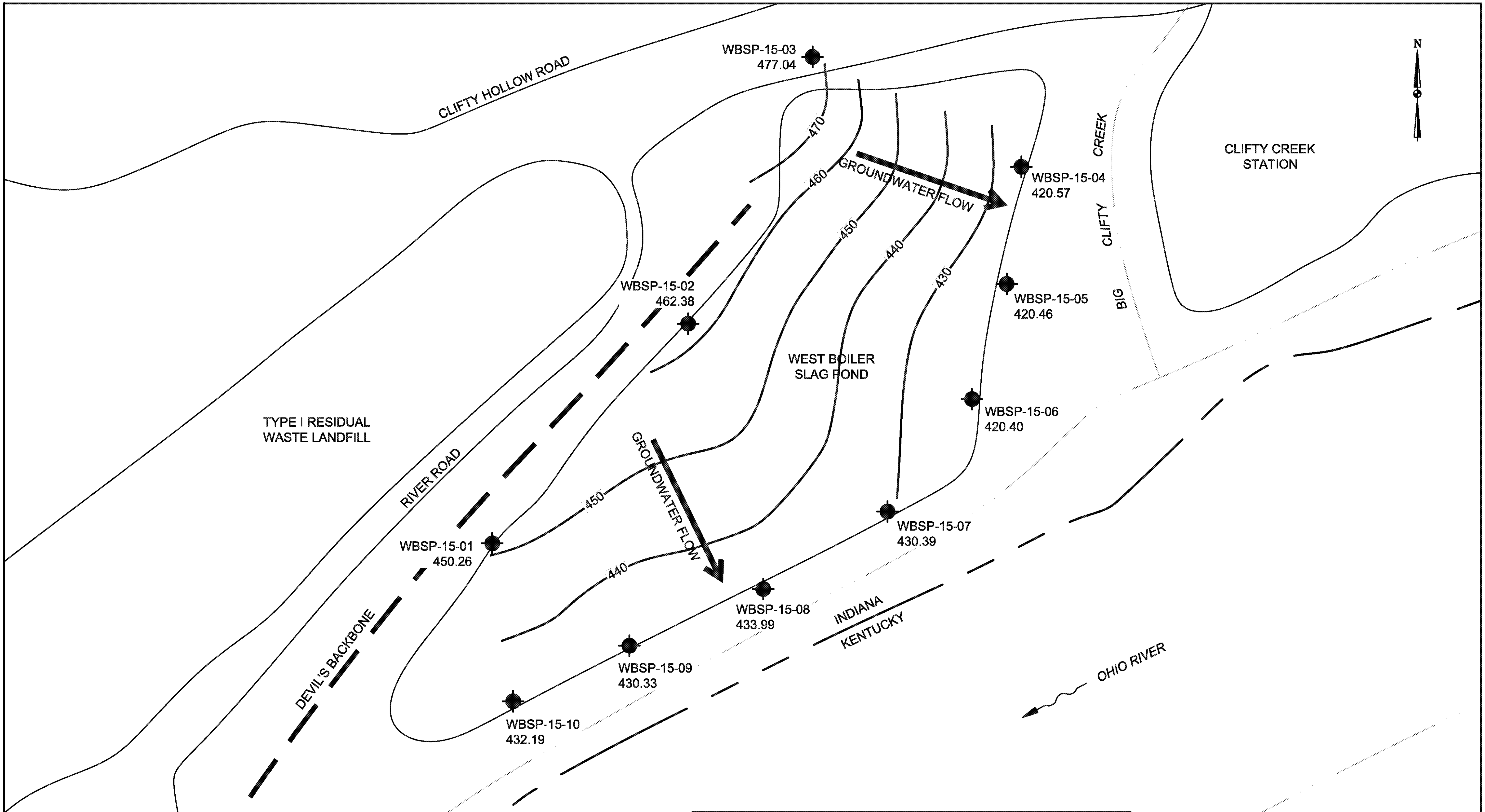
CLIFTY CREEK STATION
MADISON, INDIANA
WEST BOILER SLAG POND
GROUNDWATER LEVELS & FLOW DIRECTION – JULY 2016

DRAWING NAME: FIGURE B–22

REV. 0

Plot: 01/17/2018 11:40 _PROGRAMS–IKEC\Clifty Creek–CCR Program\CAD\2017 GW Monitoring–Corrective Action Rpt–Appx B\IKEC_Clifty_Corrective Action_Appx B_July16 b04.dwg\B–22



LEGEND:

- MONITORING WELL LOCATION
- GROUNDWATER FLOW DIRECTION

400' 0' 400' 800'

SCALE: 1"= 400'

DRAWN BY	JM
DATE	
CHECKED BY	
JOB NO.	2017114-CLI
DWG FILE	IKEC_Clifty_Corrective Action_Appx B_Aug16 b05.dwg
DRAWING SCALE	AS SHOWN

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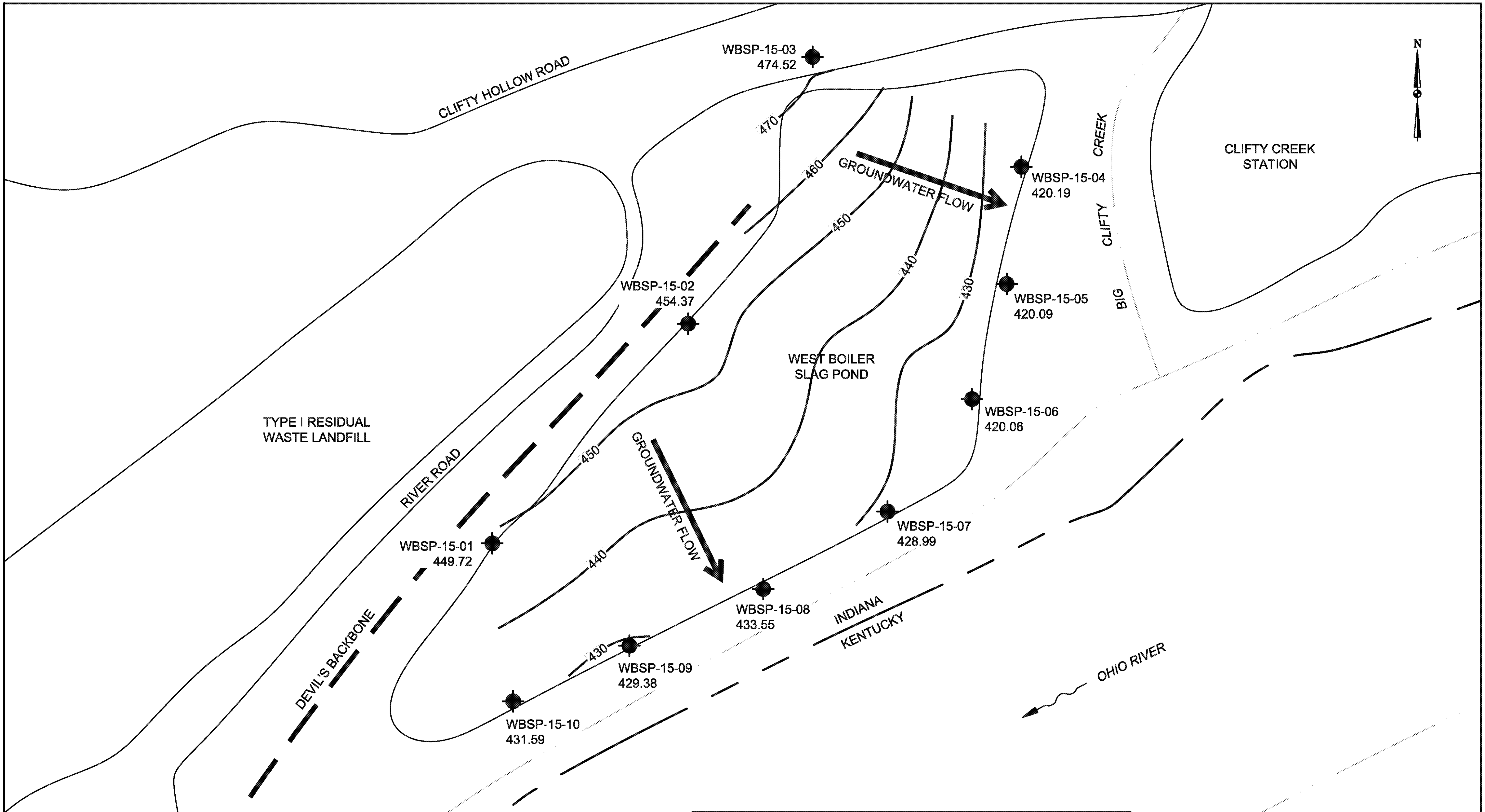
INDIANA–KENTUCKY ELECTRIC CORPORATION

CLIFTY CREEK STATION
MADISON, INDIANA
WEST BOILER SLAG POND
GROUNDWATER LEVELS & FLOW DIRECTION – AUGUST 2016

DRAWING NAME: FIGURE B–23
REV. 0

Plot: 01/18/2018 10:15 _PROGRAMS–IKEC\Clifty Creek–CCR Program\CAD\2017 GW Monitoring–Corrective Action Rpt–Appx B\IKEC_Clifty_Corrective Action_Appx B_Aug16 b05.dwg\B–23

ED_006570_00010329-00231



LEGEND:

- MONITORING WELL LOCATION
- GROUNDWATER FLOW DIRECTION

400' 0' 400' 800'

SCALE: 1"= 400'

DRAWN BY	JM
DATE	
CHECKED BY	
JOB NO.	2017114-CLI
DWG FILE	IKEC_Clifty_Corrective Action_Appx B_Nov16 b06.dwg
DRAWING SCALE	AS SHOWN

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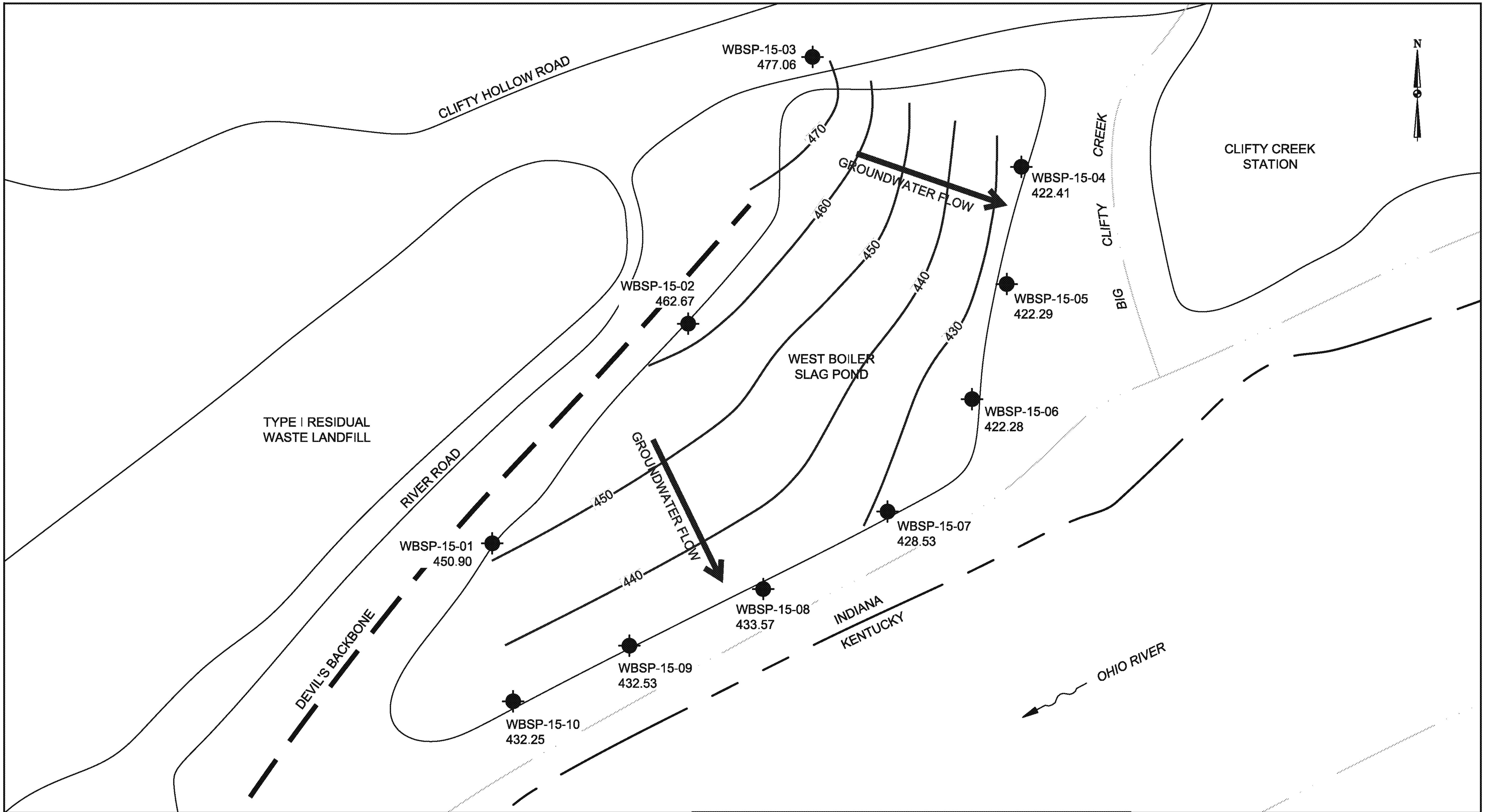
CLIFTY CREEK STATION
MADISON, INDIANA
WEST BOILER SLAG POND
GROUNDWATER LEVELS & FLOW DIRECTION – NOVEMBER 2016

DRAWING NAME: FIGURE B–24

REV. 0

Plot: 01/18/2018 13:45 _PROGRAMS–IKEC\Clifty Creek–CCR Program\CAD\2017 GW Monitoring–Corrective Action Rpt–Appx B\IKEC_Clifty_Corrective Action_Appx B_Nov16 b06.dwg\B–24



LEGEND:

- MONITORING WELL LOCATION
- GROUNDWATER FLOW DIRECTION

400' 0' 400' 800'

SCALE: 1"= 400'

DRAWN BY	JM
DATE	
CHECKED BY	
JOB NO.	2017114-CLI
DWG FILE	IKEC_Clifty_Corrective Action_Appx B_Feb17 b07.dwg
DRAWING SCALE	AS SHOWN

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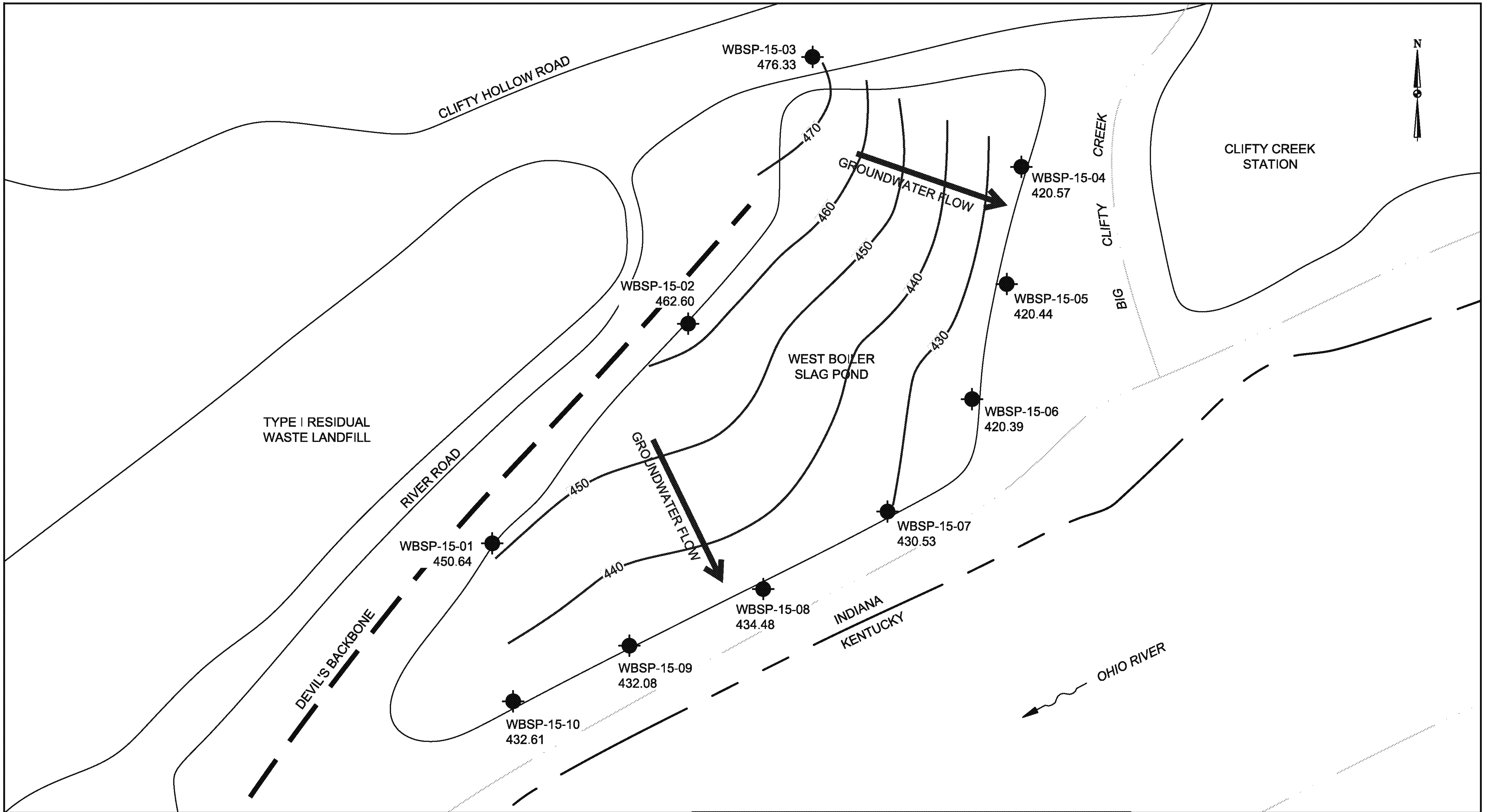
CLIFTY CREEK STATION
MADISON, INDIANA
WEST BOILER SLAG POND
GROUNDWATER LEVELS & FLOW DIRECTION – FEBRUARY 2017

DRAWING NAME: FIGURE B-25 REV. 0

Plot: 01/18/2018 15:04 _PROGRAMS-IKEC\Clifty Creek-CCR Program\CAD\2017 GW Monitoring-Corrective Action Rpt-Appx B\IKEC_Clifty_Corrective Action_Appx B_Feb17 b07.dwg\B-25



LEGEND:

- MONITORING WELL LOCATION
- GROUNDWATER FLOW DIRECTION

400' 0' 400' 800'

SCALE: 1"= 400'

DRAWN BY	JM
DATE	
CHECKED BY	
JOB NO.	2017114-CLI
DWG FILE	IKEC_Clifty_Corrective Action_Appx B_Jun17 b08.dwg
DRAWING SCALE	AS SHOWN

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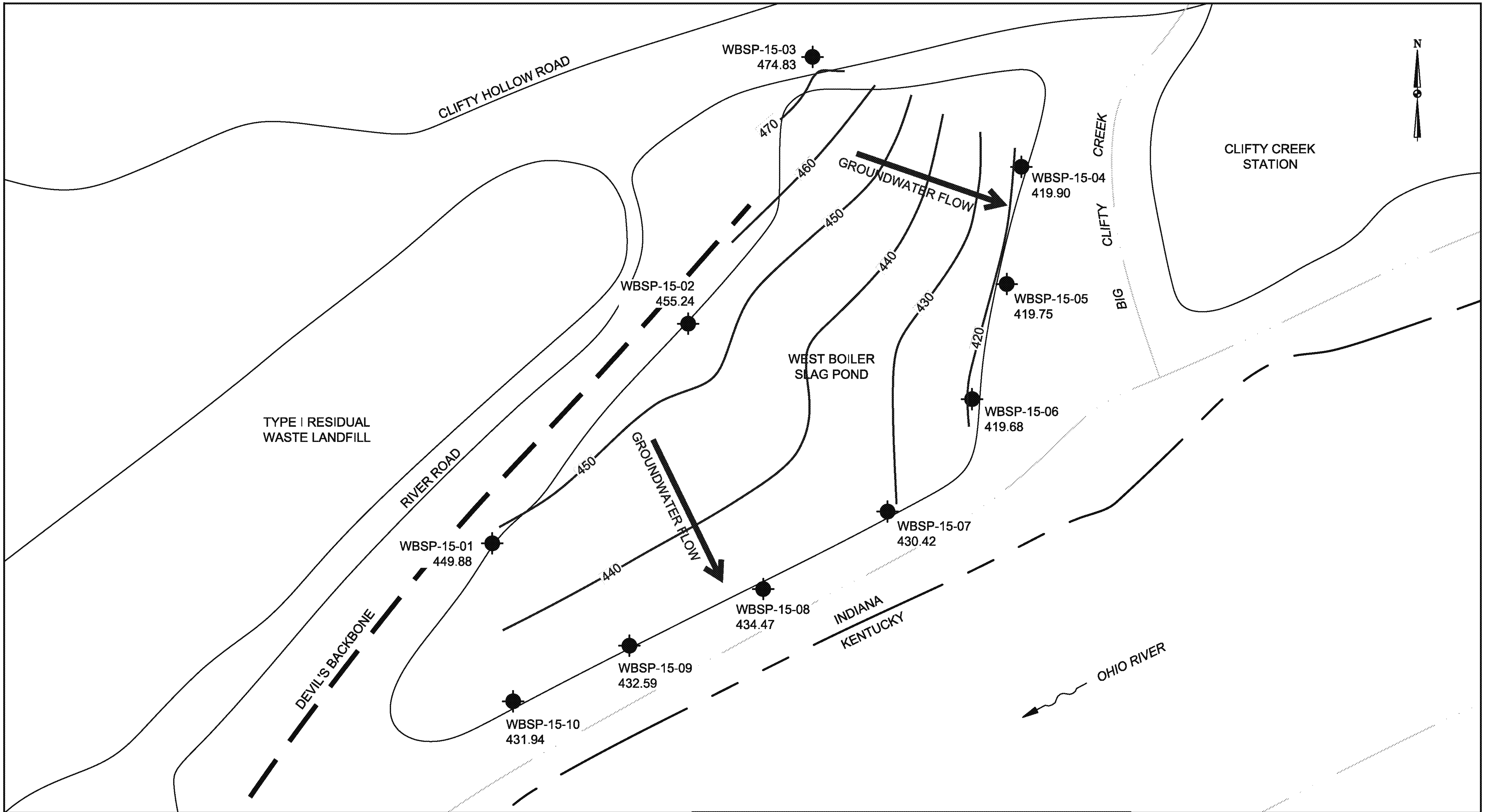
INDIANA–KENTUCKY ELECTRIC CORPORATION

CLIFTY CREEK STATION
MADISON, INDIANA
WEST BOILER SLAG POND
GROUNDWATER LEVELS & FLOW DIRECTION – JUNE 2017

DRAWING NAME: FIGURE B–26

REV. 0

Plot: 01/18/2018 16:01 _PROGRAMS–IKEC\Clifty Creek–CCR Program\CAD\2017 GW Monitoring–Corrective Action Rpt–Appx B\IKEC_Clifty_Corrective Action_Appx B_Jun17 b08.dwg\B–26



LEGEND:

● MONITORING WELL LOCATION

← GROUNDWATER FLOW DIRECTION

400' 0' 400' 800'

SCALE: 1"= 400'

DRAWN BY	JM
DATE	
CHECKED BY	
JOB NO.	2017114–CLI
DWG FILE	IKEC_Clifty_Corrective Action_Appx B_Aug17 b09.dwg
DRAWING SCALE	AS SHOWN

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INDIANA–KENTUCKY ELECTRIC CORPORATION

CLIFTY CREEK STATION
MADISON, INDIANA
WEST BOILER SLAG POND
GROUNDWATER LEVELS & FLOW DIRECTION – AUGUST 2017

DRAWING NAME: FIGURE B–27

REV. 0

Plot: 01/19/2018 15:30 _PROGRAMS–IKEC\Clifty Creek–CCR Program\CAD\2017 GW Monitoring–Corrective Action Rpt–Appx B\IKEC_Clifty_Corrective Action_Appx B_Aug17 b09.dwg\B–27

APPENDIX E3 – GROUNDWATER MONITORING RESULTS

CF-15-04
SUMMARY OF 2015-2020 ANALYTICAL RESULTS
Indiana-Kentucky Electric Corporation
Clifty Creek Station
Madison, Indiana

Parameter	Units	Jan-16	Mar-16	May-16	Jul-16	Aug-16	Nov-16	Feb-17
Appendix III Constituents								
Boron, B	mg/L	0.052	0.035	0.028	0.047	0.055	0.043	0.023
Calcium, Ca	mg/L	67.2	56	56.2	68.9	68.1	69.2	58.1
Chloride, Cl	mg/L	19.6	40.9	21.3	31.7	20.5	32.2	32.3
Fluoride, F	mg/L	0.25 U	0.12	0.14	0.1 J	0.1 J	0.09 J	0.1 J
pH	s.u.	7.72	7.56	7.51	7.45	7.27	6.19	7.46
Sulfate, SO4	mg/L	30.1	27.7	24.6	25.4	23.4	32.2	26.8
Total Dissolved Solids (TDS)	mg/L	278	314	282	294	270	294	288
Appendix IV Constituents								
Antimony, Sb	ug/L	0.1 U	0.11	0.1	0.1	0.15	0.1	0.09
Arsenic, As	ug/L	0.33	0.69	0.33	0.36	0.46	0.52	0.38
Barium, Ba	ug/L	39.9	41.7	39.2	50.8	47.9	50.9	38.2
Beryllium, Be	ug/L	0.01 U	0.028	0.02 U	0.007 J	0.01 J	0.007 J	0.02 J
Cadmium, Cd	ug/L	0.05 U	0.02	0.007 J	0.07	0.02 J	0.009 J	0.009 J
Chromium, Cr	ug/L	0.2	0.6	0.3	0.4	0.3	0.299	0.381
Cobalt, Co	ug/L	0.086	0.53	0.094	0.115	0.157	0.176	0.106
Fluoride, F	mg/L	0.25 U	0.12	0.14	0.1 J	0.1 J	0.09 J	0.1 J
Lithium, Li	mg/L	0.005 U	0.011	0.001 U	0.018	0.003	0.001 U	0.005
Lead, Pb	ug/L	0.182	0.631	0.103	0.237	0.191	0.096	0.268
Mercury, Hg	ug/L	0.005 U	0.003 J	0.005 U	0.2 U	0.005 U	0.004 J	0.002 J
Molybdenum, Mo	ug/L	1.05	0.91	2.8	1.09	1.83	3.21	0.83
Radium 226 & 228 (combined)	pCi/L	0.0803 U	0.526 U	0.1095	0.962	0.261	0.5	0.631
Selenium, Se	ug/L	0.2	0.3	0.1	0.3	0.2	0.2	0.4
Thallium, Tl	ug/L	0.02 U	0.02 J	0.05 U	0.059	0.212	0.01 J	0.01 J

Notes:
NA: Sampling not required for this parameter or well dry.

CF-15-04
SUMMARY OF 2015-2020 ANALYTICAL RESULTS
Indiana-Kentucky Electric Corporation
Clifty Creek Station
Madison, Indiana

Parameter	Units	Jun-17	Aug-17	Mar-18	Oct-18	Mar-19	Oct-19	Mar-20
Appendix III Constituents								
Boron, B	mg/L	0.106	0.06	0.043	0.09 J	0.045 J	0.058 J	0.1
Calcium, Ca	mg/L	63	68.8	106	74.2	85	74	82
Chloride, Cl	mg/L	28.5	38.3	282	50.2	11	37	6.9
Fluoride, F	mg/L	0.1 J	0.1 J	0.09	0.12	0.085	0.11	0.11
pH	s.u.	6.77	7.33	10.06	7.76	6.65	7.23	6.52
Sulfate, SO4	mg/L	24.8	31.4	35.2	34.4	28	37	26
Total Dissolved Solids (TDS)	mg/L	326	304	788	377	340	360	290
Appendix IV Constituents								
Antimony, Sb	ug/L	0.11	0.09	NA	0.1 J	2 U	2 U	2 U
Arsenic, As	ug/L	0.36	0.45	NA	0.38	5 U	5 U	5 U
Barium, Ba	ug/L	48	51.3	NA	57.5	50	46	46
Beryllium, Be	ug/L	0.007 J	0.01 J	NA	0.1 U	1 U	1 U	1 U
Cadmium, Cd	ug/L	0.01 J	0.01 J	NA	0.05 U	1 U	1 U	1 U
Chromium, Cr	ug/L	0.301	0.317	NA	0.2 J	2 U	2 U	2 U
Cobalt, Co	ug/L	0.104	0.182	NA	0.114	1 U	1 U	1 U
Fluoride, F	mg/L	0.1 J	0.1 J	NA	0.12	0.085	0.11	0.11
Lithium, Li	mg/L	0.002	0.008	NA	0.009 J	1 U	1 U	0.0017 J
Lead, Pb	ug/L	0.104	0.199	NA	0.141	0.008 U	0.008 U	1 U
Mercury, Hg	ug/L	0.932	0.005 U	NA	0.003 J	0.2 U	0.2 U	0.2 U
Molybdenum, Mo	ug/L	1.07	1.29	NA	2.54	5 U	1.1 J	1.7 J
Radium 226 & 228 (combined)	pCi/L	8.02	0.1274	NA	0.62	5 U	0.519	5 U
Selenium, Se	ug/L	0.3	0.1	NA	0.2 J	5 U	5 U	5 U
Thallium, Tl	ug/L	0.01 J	0.01 J	NA	0.5 U	1 U	1 U	1 U

Notes:
NA: Sampling not required for this parameter or well dry.

CF-15-05
SUMMARY OF 2015-2020 ANALYTICAL RESULTS
Indiana-Kentucky Electric Corporation
Clifty Creek Station
Madison, Indiana

Parameter	Units	Jan-16	Mar-16	May-16	Jul-16	Aug-16	Nov-16	Feb-17
Appendix III Constituents								
Boron, B	mg/L	0.134	0.105	0.085	0.118	0.126	0.12	0.124
Calcium, Ca	mg/L	112	116	110	109	113	111	105
Chloride, Cl	mg/L	17.2	24.6	24.5	13.8	22.6	29.5	26.1
Fluoride, F	mg/L	0.39	0.44	0.46	0.55	0.43	0.43	0.42
pH	s.u.	7.3	6.06	7.44	7.38	7.2	6.1	6.91
Sulfate, SO4	mg/L	37.8	35.8	36.2	20.2	34.8	40.1	35.3
Total Dissolved Solids (TDS)	mg/L	472	542	524	522	520	490	530
Appendix IV Constituents								
Antimony, Sb	ug/L	0.1 U	0.06	0.12	0.08	0.04 J	0.06	0.06
Arsenic, As	ug/L	4.45	2.1	2.69	2.42	1.46	1.91	1.79
Barium, Ba	ug/L	138	97.4	106	96.4	93.9	63.2	71.2
Beryllium, Be	ug/L	0.018	0.024	0.04	0.02 J	0.02 J	0.01 J	0.02 J
Cadmium, Cd	ug/L	0.05 U	0.02 J	0.01 J	0.008 J	0.008 J	0.01 J	0.02
Chromium, Cr	ug/L	0.3	0.2	0.7	0.5	0.5	0.253	0.43
Cobalt, Co	ug/L	0.749	0.686	0.749	0.517	0.498	0.399	0.644
Fluoride, F	mg/L	0.39	0.44	0.46	0.55	0.43	0.43	0.42
Lithium, Li	mg/L	0.005	0.012	0.008	0.013	0.012	0.015	0.016
Lead, Pb	ug/L	0.266	0.433	0.691	0.325	0.323	0.175	0.356
Mercury, Hg	ug/L	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.003 J	0.005 U
Molybdenum, Mo	ug/L	4.2	1.08	1.96	4.71	6	1.3	1.6
Radium 226 & 228 (combined)	pCi/L	0.2787	0.519 U	0.563	0.879	1.101	0.695	0.169
Selenium, Se	ug/L	0.1 U	0.1	0.1	0.08 J	0.1 J	0.07 J	0.1
Thallium, Tl	ug/L	0.02 U	0.02 J	0.083	0.02 J	0.03 J	0.03 J	0.085

Notes:
NA: Sampling not required for this parameter or well dry.

CF-15-05
SUMMARY OF 2015-2020 ANALYTICAL RESULTS
Indiana-Kentucky Electric Corporation
Clifty Creek Station
Madison, Indiana

Parameter	Units	Jun-17	Aug-17	Mar-18	Oct-18	Mar-19	Oct-19	Mar-20
Appendix III Constituents								
Boron, B	mg/L	0.137	0.102	0.209	0.174	0.14	0.13	0.19
Calcium, Ca	mg/L	101	105	103	113	120	110	100
Chloride, Cl	mg/L	29.6	29.9	31.5	30.2	31	33	35
Fluoride, F	mg/L	0.44	0.44	0.47	0.48	0.5	0.5	0.5
pH	s.u.	7.16	7.18	9.56	7.18	6.77	7.12	7.59
Sulfate, SO4	mg/L	40.3	43.2	44.3	40.9	49	51	53
Total Dissolved Solids (TDS)	mg/L	513	520	528	502	520	520	520
Appendix IV Constituents								
Antimony, Sb	ug/L	0.03 J	0.06	NA	0.02 J	2 U	2 U	2 U
Arsenic, As	ug/L	1.16	1.35	NA	0.91	0.77 J	0.92 J	5 U
Barium, Ba	ug/L	69.2	68	NA	58.8	59	48	51
Beryllium, Be	ug/L	0.009 J	0.01 J	NA	0.1 U	0.47 J	1 U	1 U
Cadmium, Cd	ug/L	0.02	0.01 J	NA	0.04 J	1 U	1 U	1 U
Chromium, Cr	ug/L	0.17	0.269	NA	0.228	2 U	2 U	2 U
Cobalt, Co	ug/L	0.42	0.446	NA	0.463	0.49 J	0.46 J	0.92 J
Fluoride, F	mg/L	0.44	0.44	NA	0.48	0.5	0.5	0.5
Lithium, Li	mg/L	0.011	0.019	NA	0.01 J	1 U	1 U	0.017
Lead, Pb	ug/L	0.155	0.227	NA	0.21	0.014	0.016	1 U
Mercury, Hg	ug/L	0.522	0.005 U	NA	0.003 J	0.2 U	0.2 U	0.2 U
Molybdenum, Mo	ug/L	1.48	1.34	NA	2.94	5 U	5 U	3.7 J
Radium 226 & 228 (combined)	pCi/L	3.996	1.475	NA	0.484	5 U	0.46	0.439
Selenium, Se	ug/L	0.09 J	0.08 J	NA	0.06 J	5 U	5 U	5 U
Thallium, Tl	ug/L	0.02 J	0.04 J	NA	0.5 U	1 U	1 U	1 U

Notes:
NA: Sampling not required for this parameter or well dry.

CF-15-06
SUMMARY OF 2015-2020 ANALYTICAL RESULTS
Indiana-Kentucky Electric Corporation
Clifty Creek Station
Madison, Indiana

Parameter	Units	Jan-16	Mar-16	May-16	Jul-16	Aug-16	Nov-16	Feb-17
Appendix III Constituents								
Boron, B	mg/L	0.179	0.083	0.083	NA	NA	NA	0.139
Calcium, Ca	mg/L	149	126	130	NA	NA	NA	125
Chloride, Cl	mg/L	8.14	5.54	5.55	NA	NA	NA	8.96
Fluoride, F	mg/L	0.16	0.2 U	0.24	NA	NA	NA	0.2
pH	s.u.	7.04	6.06	7.46	NA	NA	NA	7.54
Sulfate, SO4	mg/L	109	91	102	NA	NA	NA	104
Total Dissolved Solids (TDS)	mg/L	636	628	594	NA	NA	NA	606
Appendix IV Constituents								
Antimony, Sb	ug/L	0.1 U	0.08	0.03 J	NA	NA	NA	0.04 J
Arsenic, As	ug/L	0.56	0.42	0.32	NA	NA	NA	0.32
Barium, Ba	ug/L	57	40	33	NA	NA	NA	33.7
Beryllium, Be	ug/L	0.021	0.006 J	0.006 J	NA	NA	NA	0.02 U
Cadmium, Cd	ug/L	0.06	0.04	0.04	NA	NA	NA	0.08
Chromium, Cr	ug/L	0.7	0.4	0.5	NA	NA	NA	0.685
Cobalt, Co	ug/L	0.497	0.653	0.191	NA	NA	NA	0.163
Fluoride, F	mg/L	0.16	0.2 U	0.24	NA	NA	NA	0.2
Lithium, Li	mg/L	0.012	0.017	0.012	NA	NA	NA	0.017
Lead, Pb	ug/L	0.333	0.082	0.424	NA	NA	NA	0.187
Mercury, Hg	ug/L	0.005 U	0.005 U	0.005 U	NA	NA	NA	0.005 U
Molybdenum, Mo	ug/L	1.42	0.45	0.47	NA	NA	NA	0.96
Radium 226 & 228 (combined)	pCi/L	0.258	1.14 U	0.416	NA	NA	NA	1.357
Selenium, Se	ug/L	0.2	0.4	0.09 J	NA	NA	NA	0.2
Thallium, Tl	ug/L	0.048	0.01 J	0.03 J	NA	NA	NA	0.172

Notes:
NA: Sampling not required for this parameter or well dry.

CF-15-06
SUMMARY OF 2015-2020 ANALYTICAL RESULTS
Indiana-Kentucky Electric Corporation
Clifty Creek Station
Madison, Indiana

Parameter	Units	Jun-17	Aug-17	Mar-18	Oct-18	Mar-19	Oct-19	Mar-20
Appendix III Constituents								
Boron, B	mg/L	NA	NA	0.16	0.05 J	0.24	NA	0.21
Calcium, Ca	mg/L	NA	NA	125	184	120	NA	120
Chloride, Cl	mg/L	NA	NA	7.76	8.21	4.2	NA	5.1
Fluoride, F	mg/L	NA	NA	0.2	0.21	0.2	NA	0.22
pH	s.u.	NA	NA	10.36	7.89	6.99	NA	7.56
Sulfate, SO4	mg/L	NA	NA	112	102	95	NA	88
Total Dissolved Solids (TDS)	mg/L	NA	NA	630	696	560	NA	530
Appendix IV Constituents								
Antimony, Sb	ug/L	NA	NA	NA	0.07 J	2 U	NA	2 U
Arsenic, As	ug/L	NA	NA	NA	1.21	5 U	NA	5 U
Barium, Ba	ug/L	NA	NA	NA	149	30	NA	30
Beryllium, Be	ug/L	NA	NA	NA	0.934	1 U	NA	1 U
Cadmium, Cd	ug/L	NA	NA	NA	0.3	1 U	NA	1 U
Chromium, Cr	ug/L	NA	NA	NA	6.81	1.1 J	NA	0.98 J
Cobalt, Co	ug/L	NA	NA	NA	8.27	0.22 J	NA	0.59 J
Fluoride, F	mg/L	NA	NA	NA	0.21	0.2	NA	0.22
Lithium, Li	mg/L	NA	NA	NA	0.02 J	1 U	NA	0.014
Lead, Pb	ug/L	NA	NA	NA	15.7	0.015 B	NA	0.48 J
Mercury, Hg	ug/L	NA	NA	NA	0.006	0.2 U	NA	0.2 U
Molybdenum, Mo	ug/L	NA	NA	NA	3.02	5 U	NA	23
Radium 226 & 228 (combined)	pCi/L	NA	NA	NA	NA	5 U	NA	0.449
Selenium, Se	ug/L	NA	NA	NA	1.9	5 U	NA	5 U
Thallium, Tl	ug/L	NA	NA	NA	0.5 U	1 U	NA	1 U

Notes:
NA: Sampling not required for this parameter or well dry.

CF-15-07
SUMMARY OF 2015-2020 ANALYTICAL RESULTS
Indiana-Kentucky Electric Corporation
Clifty Creek Station
Madison, Indiana

Parameter	Units	Jan-16	Mar-16	May-16	Jul-16	Aug-16	Nov-16	Feb-17
Appendix III Constituents								
Boron, B	mg/L	0.057	0.032	0.022	0.045	0.046	0.053	0.021
Calcium, Ca	mg/L	174	146	152	159	160	159	159
Chloride, Cl	mg/L	5.24	5.67	5.34	5.57	5.15	5.52	5.07
Fluoride, F	mg/L	0.25 U	0.2 U	0.22	0.23	0.2	0.19	0.23
pH	s.u.	7.44	6.78	7.4	7.17	7.48	7.87	6.99
Sulfate, SO4	mg/L	4.7	6.4	7.1	8	7.1	3.5	2.1
Total Dissolved Solids (TDS)	mg/L	630	608	602	596	584	578	602
Appendix IV Constituents								
Antimony, Sb	ug/L	0.1 U	0.04 J	0.05 J	0.04 J	0.05	0.03 J	0.04 J
Arsenic, As	ug/L	4.08	2.51	4.47	4.83	5.4	6.12	6.22
Barium, Ba	ug/L	80.2	73.6	71.8	74.9	81.2	77.3	79.1
Beryllium, Be	ug/L	0.038	0.02 J	0.02 J	0.02 J	0.029	0.01 J	0.021
Cadmium, Cd	ug/L	0.05 U	0.02 J	0.02	0.02 J	0.02	0.02 J	0.01 J
Chromium, Cr	ug/L	1	0.3	0.3	0.5	0.7	0.299	0.395
Cobalt, Co	ug/L	3.95	3.35	2.94	2.81	3.11	2.61	3.03
Fluoride, F	mg/L	0.25 U	0.2 U	0.22	0.23	0.2	0.19	0.23
Lithium, Li	mg/L	0.005 U	0.002 J	0.001 U	0.001 U	0.004	0.001 U	0.007
Lead, Pb	ug/L	0.809	0.197	0.207	0.258	0.452	0.158	0.298
Mercury, Hg	ug/L	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.002 J	0.003 J
Molybdenum, Mo	ug/L	2.18	1.99	1.57	3.2	2.6	3.03	2.49
Radium 226 & 228 (combined)	pCi/L	0.111	0.77 U	0.3301	1.4843	0.296	0.781	0.2136
Selenium, Se	ug/L	0.3	0.1	0.1 J	0.1	0.2	0.1	0.1
Thallium, Tl	ug/L	0.031	0.04 J	0.03 J	0.02 J	0.063	0.03 J	0.02 J

Notes:
NA: Sampling not required for this parameter or well dry.

CF-15-07
SUMMARY OF 2015-2020 ANALYTICAL RESULTS
Indiana-Kentucky Electric Corporation
Clifty Creek Station
Madison, Indiana

Parameter	Units	Jun-17	Aug-17	Mar-18	Oct-18	Mar-19	Oct-19	Mar-20
Appendix III Constituents								
Boron, B	mg/L	0.05	0.059	0.204	0.112	0.045 J	0.08 J	0.42
Calcium, Ca	mg/L	144	151	123	168	150	160	150
Chloride, Cl	mg/L	5.25	5.13	10.6	5.34	5.6	5	11
Fluoride, F	mg/L	0.21	0.21	0.2	0.24	0.21	0.26	0.22
pH	s.u.	6.69	7.14	10.12	7.29	7.04	7.02	7.49
Sulfate, SO4	mg/L	2.5	2.8	32.7	2.7	11	5.9	63
Total Dissolved Solids (TDS)	mg/L	606	592	548	1240	620	600	620
Appendix IV Constituents								
Antimony, Sb	ug/L	0.02 J	0.03 J	NA	0.06 J	2 U	2 U	2 U
Arsenic, As	ug/L	5.07	5.32	NA	6.81	4.6 J	7.5	3.7 J
Barium, Ba	ug/L	77.8	77.2	NA	92.4	81	80	74
Beryllium, Be	ug/L	0.01 J	0.007 J	NA	0.1 U	1 U	1 U	1 U
Cadmium, Cd	ug/L	0.02	0.007 J	NA	0.07	1 U	1 U	1 U
Chromium, Cr	ug/L	0.144	0.187	NA	0.36	2 U	2 U	2 U
Cobalt, Co	ug/L	2.8	2.82	NA	2.41	2.4	2.6	2.1
Fluoride, F	mg/L	0.21	0.21	NA	0.24	0.21	0.26	0.22
Lithium, Li	mg/L	0.002	0.006	NA	0.03 U	1 U	1 U	0.005 J
Lead, Pb	ug/L	0.12	0.11	NA	0.336	0.0017 J	0.0031 J	1 U
Mercury, Hg	ug/L	1.12	0.005 U	NA	0.004 J	0.2 U	0.2 U	0.2 U
Molybdenum, Mo	ug/L	1.69	2.86	NA	12.8	4.9 J	9.5 B	110
Radium 226 & 228 (combined)	pCi/L	14.215	0.4738	NA	0.387	2.34	0.329 U	0.884
Selenium, Se	ug/L	0.2	0.1	NA	0.2 J	5 U	5 U	1.1 J
Thallium, Tl	ug/L	0.01 J	0.01 J	NA	0.5 U	1 U	1 U	1 U

Notes:
NA: Sampling not required for this parameter or well dry.

CF-15-07
SUMMARY OF 2015-2020 ANALYTICAL RESULTS
Indiana-Kentucky Electric Corporation
Clifty Creek Station
Madison, Indiana

Parameter	Units	Jun-20
Appendix III Constituents		
Boron, B	mg/L	NA
Calcium, Ca	mg/L	NA
Chloride, Cl	mg/L	NA
Fluoride, F	mg/L	NA
pH	s.u.	NA
Sulfate, SO4	mg/L	NA
Total Dissolved Solids (TDS)	mg/L	NA
Appendix IV Constituents		
Antimony, Sb	ug/L	NA
Arsenic, As	ug/L	NA
Barium, Ba	ug/L	NA
Beryllium, Be	ug/L	NA
Cadmium, Cd	ug/L	NA
Chromium, Cr	ug/L	NA
Cobalt, Co	ug/L	NA
Fluoride, F	mg/L	NA
Lithium, Li	mg/L	NA
Lead, Pb	ug/L	NA
Mercury, Hg	ug/L	NA
Molybdenum, Mo	ug/L	10
Radium 226 & 228 (combined)	pCi/L	NA
Selenium, Se	ug/L	NA
Thallium, Tl	ug/L	NA

Notes:
NA: Sampling not required for this parameter or well dry.

CF-15-08
SUMMARY OF 2015-2020 ANALYTICAL RESULTS
Indiana-Kentucky Electric Corporation
Clifty Creek Station
Madison, Indiana

Parameter	Units	Jan-16	Mar-16	May-16	Jul-16	Aug-16	Nov-16	Feb-17
Appendix III Constituents								
Boron, B	mg/L	8.64	8.24	9.34	9.65	9.63	10.9	9.29
Calcium, Ca	mg/L	119	126	131	138	138	133	143
Chloride, Cl	mg/L	18.3	16	15.6	17.5	17.8	17.4	15.9
Fluoride, F	mg/L	0.41	0.42	0.41	0.27	0.38	0.36	0.34
pH	s.u.	7.69	6.83	7.5	7.49	7.53	6.64	7.28
Sulfate, SO4	mg/L	225	199	223	247	247	238	203
Total Dissolved Solids (TDS)	mg/L	606	626	662	644	632	582	626
Appendix IV Constituents								
Antimony, Sb	ug/L	0.19	0.11	0.11	0.09	0.1	0.08	0.09
Arsenic, As	ug/L	1.99	1.32	0.99	0.72	0.83	0.66	0.82
Barium, Ba	ug/L	95.6	93	80.8	71	67.8	61.7	64.1
Beryllium, Be	ug/L	0.011	0.01 J	0.01 J	0.007 J	0.01 J	0.008 J	0.01 J
Cadmium, Cd	ug/L	0.05 U	0.07	0.03	0.07	0.04	0.02	0.04
Chromium, Cr	ug/L	0.3	0.4	0.4	0.2	0.3	0.242	0.261
Cobalt, Co	ug/L	1.38	2.08	0.649	0.416	0.45	0.327	0.49
Fluoride, F	mg/L	0.41	0.42	0.41	0.27	0.38	0.36	0.34
Lithium, Li	mg/L	0.014	0.011	0.014	0.017	0.017	0.017	0.025
Lead, Pb	ug/L	0.427	0.947	0.419	0.217	0.331	0.159	0.289
Mercury, Hg	ug/L	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.004 J	0.005 U
Molybdenum, Mo	ug/L	196	266	317	303	315	500	311
Radium 226 & 228 (combined)	pCi/L	0.299	0.335 U	0.4	0.715	0.304	0.901	8.401
Selenium, Se	ug/L	0.1	0.1	0.08 J	0.07 J	0.08 J	0.08 J	0.06 J
Thallium, Tl	ug/L	0.074	0.065	0.063	0.101	0.101	0.05 J	0.04 J

Notes:
NA: Sampling not required for this parameter or well dry.

CF-15-08
SUMMARY OF 2015-2020 ANALYTICAL RESULTS
Indiana-Kentucky Electric Corporation
Clifty Creek Station
Madison, Indiana

Parameter	Units	Jun-17	Aug-17	Mar-18	May-18	Oct-18	Mar-19	Jun-19
Appendix III Constituents								
Boron, B	mg/L	7.62	9.04	8.5	8.6	11.9	9.8	8.5
Calcium, Ca	mg/L	114	136	123	NA	145	140	NA
Chloride, Cl	mg/L	14.1	17.1	14.7	NA	17.4	14	NA
Fluoride, F	mg/L	0.34	0.36	0.41	NA	0.41	0.37	NA
pH	s.u.	7.24	7.21	10.21	7.45	7.53	7.05	NA
Sulfate, SO4	mg/L	178	233	203	NA	257	240	NA
Total Dissolved Solids (TDS)	mg/L	564	594	588	NA	636	680	NA
Appendix IV Constituents								
Antimony, Sb	ug/L	0.05	0.07	NA	NA	0.07 J	2 U	NA
Arsenic, As	ug/L	0.6	0.93	NA	NA	0.94	5 U	NA
Barium, Ba	ug/L	56.4	58.4	NA	NA	51.4	60	NA
Beryllium, Be	ug/L	0.009 J	0.01 J	NA	NA	0.1 U	1 U	NA
Cadmium, Cd	ug/L	0.02	0.05	NA	NA	0.02 J	1 U	NA
Chromium, Cr	ug/L	0.189	0.403	NA	NA	0.385	2 U	NA
Cobalt, Co	ug/L	0.29	0.537	NA	NA	0.547	0.19 J	NA
Fluoride, F	mg/L	0.34	0.36	NA	NA	0.41	0.37	NA
Lithium, Li	mg/L	0.015	0.022	NA	NA	0.02 J	1 U	NA
Lead, Pb	ug/L	0.156	0.457	NA	NA	0.457	0.017	NA
Mercury, Hg	ug/L	1.26	0.005 U	NA	NA	0.004 J	0.2 U	NA
Molybdenum, Mo	ug/L	391	425	NA	NA	524	380	360
Radium 226 & 228 (combined)	pCi/L	0.792	0.583	NA	NA	0.437	0.413	NA
Selenium, Se	ug/L	0.04 J	0.07 J	NA	NA	0.07 J	5 U	NA
Thallium, Tl	ug/L	0.05 J	0.056	NA	NA	0.5 U	1 U	NA

Notes:
NA: Sampling not required for this parameter or well dry.

CF-15-08
SUMMARY OF 2015-2020 ANALYTICAL RESULTS
Indiana-Kentucky Electric Corporation
Clifty Creek Station
Madison, Indiana

Parameter	**Units**	**Oct-19**	**Nov-19**	**Mar-20**	**Jun-20**
Appendix III Constituents					
Boron, B	mg/L	11	9	8.2	9.6
Calcium, Ca	mg/L	140	NA	130	NA
Chloride, Cl	mg/L	16	NA	15	NA
Fluoride, F	mg/L	0.4	NA	0.43	NA
pH	s.u.	7.29	NA	7.79	NA
Sulfate, SO4	mg/L	230	NA	240	NA
Total Dissolved Solids (TDS)	mg/L	650	NA	640	NA
Appendix IV Constituents					
Antimony, Sb	ug/L	2 U	NA	2 U	NA
Arsenic, As	ug/L	1.3 J	NA	0.76 J	NA
Barium, Ba	ug/L	59	NA	56	NA
Beryllium, Be	ug/L	0.76 J B	NA	0.4 J	NA
Cadmium, Cd	ug/L	0.24 J	NA	0.27 J	NA
Chromium, Cr	ug/L	2 U	NA	2 U	NA
Cobalt, Co	ug/L	0.48 J	NA	0.57 J	NA
Fluoride, F	mg/L	0.4	NA	0.43	NA
Lithium, Li	mg/L	0.5 J	NA	0.017	NA
Lead, Pb	ug/L	0.019	NA	1 U	NA
Mercury, Hg	ug/L	0.2 U	NA	0.2 U	NA
Molybdenum, Mo	ug/L	390 B	360	240	400
Radium 226 & 228 (combined)	pCi/L	0.329 U	NA	5 U	NA
Selenium, Se	ug/L	1 J	NA	5 U	NA
Thallium, Tl	ug/L	0.76 J B	NA	0.54 J	NA

Notes:
NA: Sampling not required for this parameter or well dry.

CF-15-09
SUMMARY OF 2015-2020 ANALYTICAL RESULTS
Indiana-Kentucky Electric Corporation
Clifty Creek Station
Madison, Indiana

Parameter	Units	Jan-16	Mar-16	May-16	Jul-16	Aug-16	Nov-16	Feb-17
Appendix III Constituents								
Boron, B	mg/L	6.86	5.78	6.58	7.01	6.73	NA	6.78
Calcium, Ca	mg/L	203	165	186	394	202	NA	179
Chloride, Cl	mg/L	6.59	5.09	4.49	4.6	4.11	NA	2.58
Fluoride, F	mg/L	0.28	0.27	0.24	0.28	0.28	NA	0.33
pH	s.u.	7.58	7.1	7.44	7.48	7.65	NA	7.18
Sulfate, SO4	mg/L	359	299	286	363	309	NA	0.4
Total Dissolved Solids (TDS)	mg/L	792	743	758	1100	740	NA	200 J
Appendix IV Constituents								
Antimony, Sb	ug/L	0.13	0.09	0.08	0.11	0.09	NA	0.05 J
Arsenic, As	ug/L	0.57	0.44	0.41	3.9	0.41	NA	0.33
Barium, Ba	ug/L	28.4	22.6	21	45.3	22.2	NA	13.5
Beryllium, Be	ug/L	0.01 U	0.02 U	0.006 J	0.206	0.008 J	NA	0.008 J
Cadmium, Cd	ug/L	0.05 U	0.03	0.03	0.11	0.02	NA	0.02 J
Chromium, Cr	ug/L	0.3	0.5	0.6	7.1	0.6	NA	0.226
Cobalt, Co	ug/L	0.416	0.112	0.121	5.44	0.139	NA	0.042
Fluoride, F	mg/L	0.28	0.27	0.24	0.28	0.28	NA	0.33
Lithium, Li	mg/L	0.011	0.009	0.009	0.025	0.013	NA	0.017
Lead, Pb	ug/L	0.045	0.073	0.15	6.75	0.163	NA	0.027
Mercury, Hg	ug/L	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	NA	0.005 U
Molybdenum, Mo	ug/L	87.8	87.6	82.6	38.2	90.3	NA	82.5
Radium 226 & 228 (combined)	pCi/L	0.1	1.54 U	0.4485	1.126	0.3095	NA	0.823
Selenium, Se	ug/L	0.2	0.1	0.1	1.4	0.2	NA	0.04 J
Thallium, Tl	ug/L	0.031	0.02 J	0.02 J	0.076	0.05 J	NA	0.01 J

Notes:
NA: Sampling not required for this parameter or well dry.

CF-15-09
SUMMARY OF 2015-2020 ANALYTICAL RESULTS
Indiana-Kentucky Electric Corporation
Clifty Creek Station
Madison, Indiana

Parameter	Units	Jun-17	Aug-17	May-18	Oct-18	Mar-19	Jun-19	Oct-19
Appendix III Constituents								
Boron, B	mg/L	6.3	6.81	6.1	7.59	6.7	NA	NA
Calcium, Ca	mg/L	182	392	NA	250	160	NA	NA
Chloride, Cl	mg/L	4.12	3.77	NA	3.47	3	NA	NA
Fluoride, F	mg/L	0.27	0.26	NA	0.32	0.31	NA	NA
pH	s.u.	7.91	6.99	7.09	7.05	7.19	NA	NA
Sulfate, SO4	mg/L	305	422	NA	274	260	NA	NA
Total Dissolved Solids (TDS)	mg/L	790	970	NA	790	620	NA	NA
Appendix IV Constituents								
Antimony, Sb	ug/L	0.06	0.12	NA	0.16	2 U	NA	NA
Arsenic, As	ug/L	0.4	6.17	NA	4.67	5 U	NA	NA
Barium, Ba	ug/L	18.7	44.3	NA	38.2	14	NA	NA
Beryllium, Be	ug/L	0.007 J	0.317	NA	0.261	1.5	NA	NA
Cadmium, Cd	ug/L	0.02 J	0.08	NA	0.05 J	0.23 J	NA	NA
Chromium, Cr	ug/L	1.21	13.7	NA	14.9	2 U	NA	NA
Cobalt, Co	ug/L	0.184	13.7	NA	7.45	0.38 J	NA	NA
Fluoride, F	mg/L	0.27	0.26	NA	0.32	0.31	NA	NA
Lithium, Li	mg/L	0.012	0.035	NA	0.02 J	1 U	NA	NA
Lead, Pb	ug/L	0.191	10.2	NA	6.25	0.0087	NA	NA
Mercury, Hg	ug/L	0.005 U	0.005 U	NA	0.007	0.2 U	NA	NA
Molybdenum, Mo	ug/L	73.6	47.1	NA	85.9	100	87	NA
Radium 226 & 228 (combined)	pCi/L	0.869	NA	NA	NA	5 U	NA	NA
Selenium, Se	ug/L	0.1	2	NA	1.3	1.2 J	NA	NA
Thallium, Tl	ug/L	0.01 J	0.085	NA	0.5 U	0.2 J	NA	NA

Notes:
NA: Sampling not required for this parameter or well dry.

CF-15-09
SUMMARY OF 2015-2020 ANALYTICAL RESULTS
Indiana-Kentucky Electric Corporation
Clifty Creek Station
Madison, Indiana

Parameter	Units	Mar-20	Jun-20
Appendix III Constituents			
Boron, B	mg/L	5.7	5.9
Calcium, Ca	mg/L	170	NA
Chloride, Cl	mg/L	2.7	NA
Fluoride, F	mg/L	0.3	NA
pH	s.u.	7.59	NA
Sulfate, SO4	mg/L	280	NA
Total Dissolved Solids (TDS)	mg/L	640	NA
Appendix IV Constituents			
Antimony, Sb	ug/L	2 U	NA
Arsenic, As	ug/L	5 U	NA
Barium, Ba	ug/L	18	NA
Beryllium, Be	ug/L	1 U	NA
Cadmium, Cd	ug/L	1 U	NA
Chromium, Cr	ug/L	1.1 J	NA
Cobalt, Co	ug/L	1 U	NA
Fluoride, F	mg/L	0.3	NA
Lithium, Li	mg/L	0.0081	NA
Lead, Pb	ug/L	1 U	NA
Mercury, Hg	ug/L	0.2 U	NA
Molybdenum, Mo	ug/L	85	NA
Radium 226 & 228 (combined)	pCi/L	5 U	NA
Selenium, Se	ug/L	5 U	NA
Thallium, Tl	ug/L	1 U	NA

Notes:
NA: Sampling not required for this parameter or well dry.

CF-19-14
SUMMARY OF 2015-2020 ANALYTICAL RESULTS
Indiana-Kentucky Electric Corporation
Clifty Creek Station
Madison, Indiana

Parameter	Units	Oct-19	Mar-20
Appendix IV Constituents			
Molybdenum, Mo	ug/L	15	9.5

CF-19-15
SUMMARY OF 2015-2020 ANALYTICAL RESULTS
Indiana-Kentucky Electric Corporation
Clifty Creek Station
Madison, Indiana

Parameter	Units	Oct-19	Mar-20
Appendix IV Constituents			
Molybdenum, Mo	ug/L	1.1 J	6.1

WBSP-15-01
SUMMARY OF 2015-2020 ANALYTICAL RESULTS
Indiana-Kentucky Electric Corporation
Clifty Creek Station
Madison, Indiana

Parameter	Units	Jan-16	Mar-16	May-16	Jul-16	Aug-16	Nov-16	Feb-17
Appendix III Constituents								
Boron, B	mg/L	0.112	0.094	0.064	0.09	0.134	NA	0.133
Calcium, Ca	mg/L	143	150	182	180	160	NA	163
Chloride, Cl	mg/L	11.5	8.49	8.01	17.9	37.4	NA	42.5
Fluoride, F	mg/L	0.25 U	0.22	0.26	0.23	0.25	NA	0.27
pH	s.u.	7.47	7.21	6.75	6.67	6.17	NA	6.85
Sulfate, SO4	mg/L	97.2	120	123	169	165	NA	168
Total Dissolved Solids (TDS)	mg/L	546	642	636	750	734	NA	708
Appendix IV Constituents								
Antimony, Sb	ug/L	0.14	0.07	0.05	0.14	0.1 J	NA	0.09
Arsenic, As	ug/L	0.88	0.32	2.9	3.22	0.49	NA	1.08
Barium, Ba	ug/L	36.9	18.6	14.7	38.5	25	NA	30.4
Beryllium, Be	ug/L	0.052	0.02 U	0.007 J	0.176	0.02 J	NA	0.072
Cadmium, Cd	ug/L	0.05 U	0.008 J	0.007 J	0.07	0.05	NA	0.04
Chromium, Cr	ug/L	1.5	0.2	0.4	8.4	1.3	NA	3.43
Cobalt, Co	ug/L	0.778	0.064	0.022	4.03	0.6	NA	1.61
Fluoride, F	mg/L	0.25 U	0.22	0.26	0.23	0.25	NA	0.27
Lithium, Li	mg/L	0.007	0.013	0.021	0.029	0.024	NA	0.033
Lead, Pb	ug/L	1.14	0.044	0.233	3.74	0.585	NA	1.74
Mercury, Hg	ug/L	0.005 U	0.005 U	0.005 U	0.004 J	0.005 U	NA	0.005 U
Molybdenum, Mo	ug/L	2.26	0.88	0.74	1.26	1.18	NA	0.81
Radium 226 & 228 (combined)	pCi/L	0.137	0.524 U	3.2607	NA	NA	NA	NA
Selenium, Se	ug/L	0.2	0.1 J	0.1 U	0.5	0.1 J	NA	0.2
Thallium, Tl	ug/L	0.025	0.01 J	0.02 J	0.074	0.03 J	NA	0.04 J

Notes:
NA: Sampling not required for this parameter or well dry.

WBSP-15-01
SUMMARY OF 2015-2020 ANALYTICAL RESULTS
Indiana-Kentucky Electric Corporation
Clifty Creek Station
Madison, Indiana

Parameter	Units	Jun-17	Aug-17	Mar-18	Oct-18	Mar-19	Oct-19	Mar-20
Appendix III Constituents								
Boron, B	mg/L	0.108	NA	0.1	0.134	0.082 J	NA	0.066 J
Calcium, Ca	mg/L	154	NA	157	164	160	NA	160
Chloride, Cl	mg/L	11.3	NA	9.45	25.3	7.1	NA	6.7
Fluoride, F	mg/L	0.25	NA	0.27	0.31	0.24	NA	0.26
pH	s.u.	6.82	NA	6.65	6.37	6.76	NA	6.81
Sulfate, SO4	mg/L	133	NA	139	146	130	NA	120
Total Dissolved Solids (TDS)	mg/L	696	NA	685	711	670	NA	630
Appendix IV Constituents								
Antimony, Sb	ug/L	0.05 J	NA	NA	0.09 J	2 U	NA	NA
Arsenic, As	ug/L	0.46	NA	NA	1.52	5 U	NA	NA
Barium, Ba	ug/L	19.1	NA	NA	25.3	13	NA	NA
Beryllium, Be	ug/L	0.022	NA	NA	0.144	1.1	NA	NA
Cadmium, Cd	ug/L	0.01 J	NA	NA	0.03 J	1 U	NA	NA
Chromium, Cr	ug/L	0.98	NA	NA	4.76	1.7 J	NA	NA
Cobalt, Co	ug/L	0.441	NA	NA	2.91	0.78 J	NA	NA
Fluoride, F	mg/L	0.25	NA	NA	0.31	0.24	NA	NA
Lithium, Li	mg/L	0.03	NA	NA	0.034	0.76 J	NA	NA
Lead, Pb	ug/L	0.447	NA	NA	2.63	0.021	NA	NA
Mercury, Hg	ug/L	1.12	NA	NA	NA	0.2 U	NA	NA
Molybdenum, Mo	ug/L	0.47	NA	NA	0.7 J	5 U	NA	NA
Radium 226 & 228 (combined)	pCi/L	NA	NA	NA	NA	5 U	NA	NA
Selenium, Se	ug/L	0.2	NA	NA	0.6	5 U	NA	NA
Thallium, Tl	ug/L	0.02 J	NA	NA	0.5 U	1 U	NA	NA

Notes:
NA: Sampling not required for this parameter or well dry.

WBSP-15-02
SUMMARY OF 2015-2020 ANALYTICAL RESULTS
Indiana-Kentucky Electric Corporation
Clifty Creek Station
Madison, Indiana

Parameter	Units	Jan-16	Mar-16	May-16	Jul-16	Aug-16	Nov-16	Feb-17
Appendix III Constituents								
Boron, B	mg/L	5.02	3.92	3.04	4.39	3.06	NA	4.43
Calcium, Ca	mg/L	284	262	246	119	257	NA	254
Chloride, Cl	mg/L	12.3	12.3	13.1	14.7	12	NA	13.8
Fluoride, F	mg/L	0.2	0.31	0.24	0.38	0.32	NA	0.34
pH	s.u.	7.51	7.12	7.13	6.99	6.79	NA	6.78
Sulfate, SO4	mg/L	634	566	508	584	517	NA	558
Total Dissolved Solids (TDS)	mg/L	1290	1230	1160	1250	1140	NA	1240
Appendix IV Constituents								
Antimony, Sb	ug/L	0.13	0.36	0.17	0.1	0.13	NA	0.16
Arsenic, As	ug/L	0.71	0.6	4.47	3.9	0.47	NA	0.62
Barium, Ba	ug/L	33.6	33.7	30.9	91	28.1	NA	31.5
Beryllium, Be	ug/L	0.01 U	0.008 J	0.007 J	0.02 U	0.005 J	NA	0.01 J
Cadmium, Cd	ug/L	0.05 U	0.02 J	0.02	0.009 J	0.01 J	NA	0.03
Chromium, Cr	ug/L	0.6	0.8	0.3	0.2	0.5	NA	1.03
Cobalt, Co	ug/L	0.126	0.175	0.359	0.18	0.141	NA	0.476
Fluoride, F	mg/L	0.2	0.31	0.24	0.38	0.32	NA	0.34
Lithium, Li	mg/L	0.098	0.102	0.087	0.009	0.088	NA	0.093
Lead, Pb	ug/L	0.091	0.181	0.131	0.041	0.122	NA	0.441
Mercury, Hg	ug/L	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	NA	0.005 U
Molybdenum, Mo	ug/L	5	3.73	2.65	62.4	2.33	NA	7.72
Radium 226 & 228 (combined)	pCi/L	0.183	1.61 U	0.2887	1.98	1.48	NA	0.879
Selenium, Se	ug/L	0.1	0.2	0.05 J	0.09 J	0.08 J	NA	0.1
Thallium, Tl	ug/L	0.02 U	0.02 J	0.02 J	0.089	0.02 J	NA	0.03 J

Notes:
NA: Sampling not required for this parameter or well dry.

WBSP-15-02
SUMMARY OF 2015-2020 ANALYTICAL RESULTS
Indiana-Kentucky Electric Corporation
Clifty Creek Station
Madison, Indiana

Parameter	Units	Jun-17	Aug-17	Mar-18	Oct-18	Mar-19	Oct-19	Mar-20
Appendix III Constituents								
Boron, B	mg/L	3.58	3.72	3.98	4.36	3.3	NA	4
Calcium, Ca	mg/L	249	266	231	277	250	NA	270
Chloride, Cl	mg/L	11.4	11.7	12.1	11.3	6.5	NA	10
Fluoride, F	mg/L	0.3	0.32	0.37	0.36	0.35	NA	0.37
pH	s.u.	7.07	6.95	7.34	6.64	6.85	NA	7.35
Sulfate, SO4	mg/L	573	581	607	515	500	NA	520
Total Dissolved Solids (TDS)	mg/L	1220	1180	1200	1190	1100	NA	1200
Appendix IV Constituents								
Antimony, Sb	ug/L	0.22	0.27	NA	0.14	2 U	NA	NA
Arsenic, As	ug/L	0.97	0.78	NA	0.44	5 U	NA	NA
Barium, Ba	ug/L	33	32.6	NA	22.6	19	NA	NA
Beryllium, Be	ug/L	0.03	0.03	NA	0.1 U	1 U	NA	NA
Cadmium, Cd	ug/L	0.06	0.02	NA	0.03 J	1 U	NA	NA
Chromium, Cr	ug/L	2.5	2.14	NA	0.788	2 U	NA	NA
Cobalt, Co	ug/L	0.497	0.564	NA	0.081	1 U	NA	NA
Fluoride, F	mg/L	0.3	0.32	NA	0.36	0.35	NA	NA
Lithium, Li	mg/L	0.091	0.103	NA	0.088	1 U	NA	NA
Lead, Pb	ug/L	0.699	0.64	NA	0.09 J	0.071 B	NA	NA
Mercury, Hg	ug/L	1.16	0.005 U	NA	0.002 J	0.2 U	NA	NA
Molybdenum, Mo	ug/L	3	4.4	NA	2.45	2.3 J	NA	NA
Radium 226 & 228 (combined)	pCi/L	2.235	0.737	NA	0.3588	5 U	NA	NA
Selenium, Se	ug/L	0.2	0.1	NA	0.06 J	5 U	NA	NA
Thallium, Tl	ug/L	0.02 J	0.03 J	NA	0.5 U	1 U	NA	NA

Notes:
NA: Sampling not required for this parameter or well dry.

WBSP-15-03
SUMMARY OF 2015-2020 ANALYTICAL RESULTS
Indiana-Kentucky Electric Corporation
Clifty Creek Station
Madison, Indiana

Parameter	Units	Jan-16	Mar-16	May-16	Jul-16	Aug-16	Nov-16	Feb-17
Appendix III Constituents								
Boron, B	mg/L	0.147	0.067	0.069	0.115	0.169	0.09	0.136
Calcium, Ca	mg/L	171	78.9	99	105	134	119	137
Chloride, Cl	mg/L	84.3	142	159	69	68.4	47.4	92.1
Fluoride, F	mg/L	0.23	0.27	0.25	0.27	0.29	0.19	0.22
pH	s.u.	7.61	7.39	7.19	7.36	7.46	6.76	6.78
Sulfate, SO4	mg/L	310	62.9	80.4	76.3	125	109	193
Total Dissolved Solids (TDS)	mg/L	810	514	580	468	640	564	664
Appendix IV Constituents								
Antimony, Sb	ug/L	0.1 U	0.07	0.08	0.09	0.06 J	0.06	0.07
Arsenic, As	ug/L	0.45	0.17	3.37	0.17	0.15	0.17	0.32
Barium, Ba	ug/L	15.8	7.6	11.6	12.7	13.2	11.9	12.4
Beryllium, Be	ug/L	0.027	0.02 U	0.02 U	0.02 U	0.04 U	0.02 U	0.01 J
Cadmium, Cd	ug/L	0.05 U	0.02 U	0.02 U	0.008 J	0.04 U	0.008 J	0.006 J
Chromium, Cr	ug/L	1.9	0.1	0.2	0.1	0.1	0.108	0.32
Cobalt, Co	ug/L	0.33	0.066	0.021	0.021	0.02 J	0.019	0.21
Fluoride, F	mg/L	0.23	0.27	0.25	0.27	0.29	0.19	0.22
Lithium, Li	mg/L	0.033	0.011	0.007	0.006	0.016	0.008	0.016
Lead, Pb	ug/L	0.385	0.063	0.037	0.047	0.04 J	0.007 J	0.233
Mercury, Hg	ug/L	0.005 U	0.005 U	0.005 U	0.2 U	0.005 U	0.003 J	0.005 U
Molybdenum, Mo	ug/L	1.74	3.28	3.2	2.78	3.25	4.56	2.2
Radium 226 & 228 (combined)	pCi/L	0.124	0.546 U	0.60324	0.401	1.392	0.891	1.143
Selenium, Se	ug/L	0.3	0.2	0.06 J	0.7	0.2 J	1	0.2
Thallium, Tl	ug/L	0.02 U	0.05 U	0.01 J	0.03 J	0.03 J	0.02 J	0.02 J

Notes:
NA: Sampling not required for this parameter or well dry.

WBSP-15-03
SUMMARY OF 2015-2020 ANALYTICAL RESULTS
Indiana-Kentucky Electric Corporation
Clifty Creek Station
Madison, Indiana

Parameter	Units	Jun-17	Aug-17	Mar-18	Oct-18	Mar-19	Oct-19	Mar-20
Appendix III Constituents								
Boron, B	mg/L	0.112	0.167	0.08	0.167	0.067 J	0.22	0.29
Calcium, Ca	mg/L	68.8	155	66.2	112	100	210	97
Chloride, Cl	mg/L	51	55.5	108	63.8	110	66	55
Fluoride, F	mg/L	0.22	0.29	0.22	0.26	0.21	0.3	0.23
pH	s.u.	7.38	6.99	7.05	7.7	6.85	7.08	6.57
Sulfate, SO4	mg/L	49.6	130	59.1	98	120	330	140
Total Dissolved Solids (TDS)	mg/L	379	672	402	564	540	970	530
Appendix IV Constituents								
Antimony, Sb	ug/L	0.11	0.04 J	NA	NA	NA	NA	NA
Arsenic, As	ug/L	0.15	0.23	NA	NA	NA	NA	NA
Barium, Ba	ug/L	8.85	13.6	NA	NA	NA	NA	NA
Beryllium, Be	ug/L	0.02 U	0.006 J	NA	NA	NA	NA	NA
Cadmium, Cd	ug/L	0.006 J	0.009 J	NA	NA	NA	NA	NA
Chromium, Cr	ug/L	0.121	0.187	NA	NA	NA	NA	NA
Cobalt, Co	ug/L	0.05	0.08	NA	NA	NA	NA	NA
Fluoride, F	mg/L	0.22	0.29	NA	NA	NA	NA	NA
Lithium, Li	mg/L	0.008	0.019	NA	NA	NA	NA	NA
Lead, Pb	ug/L	0.071	0.079	NA	NA	NA	NA	NA
Mercury, Hg	ug/L	1.24	0.005 U	NA	NA	NA	NA	NA
Molybdenum, Mo	ug/L	3	1.29	NA	NA	NA	NA	NA
Radium 226 & 228 (combined)	pCi/L	0.605	0.47	NA	NA	NA	NA	NA
Selenium, Se	ug/L	0.6	0.09 J	NA	NA	NA	NA	NA
Thallium, Tl	ug/L	0.02 J	0.03 J	NA	NA	NA	NA	NA

Notes:
NA: Sampling not required for this parameter or well dry.

WBSP-15-04
SUMMARY OF 2015-2020 ANALYTICAL RESULTS
Indiana-Kentucky Electric Corporation
Clifty Creek Station
Madison, Indiana

Parameter	Units	Jan-16	Mar-16	May-16	Jul-16	Aug-16	Nov-16	Feb-17	Jun-17
Appendix III Constituents									
Boron, B	mg/L	4.55	4.11	4.36	3.49	4.24	4.52	5.11	4.62
Calcium, Ca	mg/L	106	94.4	106	287	125	110	95.5	95.1
Chloride, Cl	mg/L	70.5	66.2	71.1	13.4	78.2	71.8	67	77.5
Fluoride, F	mg/L	0.25 U	0.2 U	0.2	0.33	0.15	0.1 J	0.18	0.17
pH	s.u.	8.45	8.61	8.82	8.31	7.34	9.07	7.62	7.85
Sulfate, SO4	mg/L	193	196	212	549	237	191	175	187
Total Dissolved Solids (TDS)	mg/L	456	496	520	1180	594	428	500	507
Appendix IV Constituents									
Antimony, Sb	ug/L	0.1 U	0.14	0.31	0.5	0.19	0.12	0.13	0.11
Arsenic, As	ug/L	3.34	3.27	0.15	2.33	3.16	3.74	4.86	4.79
Barium, Ba	ug/L	92.7	91.1	89.1	49.5	92.9	79.5	78.3	84.2
Beryllium, Be	ug/L	0.01 U	0.02 U	0.02 U	0.128	0.02 J	0.02 U	0.02 U	0.02 U
Cadmium, Cd	ug/L	0.05 U	0.02 U	0.02 U	0.07	0.01 J	0.02 U	0.006 J	0.02 U
Chromium, Cr	ug/L	0.3	0.1	0.2	5.7	2.5	0.135	0.265	0.114
Cobalt, Co	ug/L	0.421	0.251	0.172	2.85	0.467	0.24	0.29	0.251
Fluoride, F	mg/L	0.25 U	0.2 U	0.2	0.33	0.15	0.1 J	0.18	0.17
Lithium, Li	mg/L	0.005	0.022	0.007	0.086	0.013	0.008	0.012	0.011
Lead, Pb	ug/L	0.247	0.075	0.03	3.16	0.373	0.041	0.079	0.042
Mercury, Hg	ug/L	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.004 J	0.005 U	0.894
Molybdenum, Mo	ug/L	52	55.9	63.6	3.1	62.8	66.4	60.1	55.5
Radium 226 & 228 (combined)	pCi/L	0.1142	0.614 U	0.283	3.504	0.90792	0.461	1.067	0.635
Selenium, Se	ug/L	0.1	0.08 J	0.3	0.5	0.1 J	0.07 J	0.1	0.09 J
Thallium, Tl	ug/L	0.02 U	0.05 U	0.01 J	0.07	0.07 J	0.01 J	0.209	0.01 J

Notes:
NA: Sampling not required for this parameter or well dry.

WBSP-15-04
SUMMARY OF 2015-2020 ANALYTICAL RESULTS
Indiana-Kentucky Electric Corporation
Clifty Creek Station
Madison, Indiana

Parameter	Units	Aug-17	Mar-18	Oct-18	Mar-19	Oct-19	Mar-20
Appendix III Constituents							
Boron, B	mg/L	4.65	4.61	4.59	5.6	5.5	5
Calcium, Ca	mg/L	110	94.1	121	130	110	100
Chloride, Cl	mg/L	83.7	63.2	113	130	92	92
Fluoride, F	mg/L	0.17	0.19	0.18	0.17	0.18	0.19
pH	s.u.	7.92	7.89	8.55	8.03	7.27	7.58
Sulfate, SO4	mg/L	209	193	205	240	210	190
Total Dissolved Solids (TDS)	mg/L	492	426	570	600	550	500
Appendix IV Constituents							
Antimony, Sb	ug/L	0.11	NA	NA	NA	NA	NA
Arsenic, As	ug/L	4.55	NA	NA	NA	NA	NA
Barium, Ba	ug/L	88.9	NA	NA	NA	NA	NA
Beryllium, Be	ug/L	0.02 U	NA	NA	NA	NA	NA
Cadmium, Cd	ug/L	0.008 J	NA	NA	NA	NA	NA
Chromium, Cr	ug/L	0.112	NA	NA	NA	NA	NA
Cobalt, Co	ug/L	0.245	NA	NA	NA	NA	NA
Fluoride, F	mg/L	0.17	NA	NA	NA	NA	NA
Lithium, Li	mg/L	0.008	NA	NA	NA	NA	NA
Lead, Pb	ug/L	0.049	NA	NA	NA	NA	NA
Mercury, Hg	ug/L	0.005 U	NA	NA	NA	NA	NA
Molybdenum, Mo	ug/L	64.8	NA	NA	NA	NA	NA
Radium 226 & 228 (combined)	pCi/L	0.698	NA	NA	NA	NA	NA
Selenium, Se	ug/L	0.08 J	NA	NA	NA	NA	NA
Thallium, Tl	ug/L	0.02 J	NA	NA	NA	NA	NA

Notes:
NA: Sampling not required for this parameter or well dry.

WBSP-15-05
SUMMARY OF 2015-2020 ANALYTICAL RESULTS
Indiana-Kentucky Electric Corporation
Clifty Creek Station
Madison, Indiana

Parameter	**Units**	**Jan-16**	**Mar-16**	**May-16**	**Jul-16**	**Aug-16**	**Nov-16**	**Feb-17**	**Jun-17**
Appendix III Constituents									
Boron, B	mg/L	2.58	2.71	2.88	2.96	2.92	2.99	2.88	2.6
Calcium, Ca	mg/L	94.9	101	113	118	117	121	104	108
Chloride, Cl	mg/L	71.7	66.9	67.9	65.7	64.9	60.8	56.7	61.3
Fluoride, F	mg/L	0.26	0.28	0.25	0.19	0.18	0.15	0.16	0.15
pH	s.u.	7.89	8.12	8.36	8.14	7.43	8.26	7.57	7.67
Sulfate, SO4	mg/L	176	190	223	234	231	217	209	219
Total Dissolved Solids (TDS)	mg/L	492	516	502	508	548	490	540	561
Appendix IV Constituents									
Antimony, Sb	ug/L	0.45	0.6	0.09	0.07	0.16	0.11	0.06	0.03 J
Arsenic, As	ug/L	7.27	6.12	0.61	2.95	3.32	2.49	2.76	3.85
Barium, Ba	ug/L	160	208	171	148	131	131	135	125
Beryllium, Be	ug/L	0.027	0.02 J	0.02 U	0.02 U	0.03 J	0.005 J	0.005 J	0.01 J
Cadmium, Cd	ug/L	0.05 U	0.02	0.02	0.04	0.06	0.04	0.03	0.02 J
Chromium, Cr	ug/L	0.8	0.4	1.2	0.2	1.1	0.189	0.26	0.424
Cobalt, Co	ug/L	0.98	1.76	1.24	1.16	1.49	1.19	1.26	1.17
Fluoride, F	mg/L	0.26	0.28	0.25	0.19	0.18	0.15	0.16	0.15
Lithium, Li	mg/L	0.005 U	0.005 J	0.0007 J	0.004	0.006	0.001	0.002	0.002
Lead, Pb	ug/L	0.753	0.272	0.052	0.081	0.534	0.192	0.147	0.142
Mercury, Hg	ug/L	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.004 J	0.005 U	1.16
Molybdenum, Mo	ug/L	150	139	118	102	100	97.5	92.8	78.9
Radium 226 & 228 (combined)	pCi/L	0.236	1	0.889	1.96	1.264	1.135	0.43	2.179
Selenium, Se	ug/L	0.1	0.1	0.2	0.05 J	0.2	0.04 J	0.05 J	0.05 J
Thallium, Tl	ug/L	0.022	0.02 J	0.05 U	0.01 J	0.05 J	0.02 J	0.072	0.05 U

Notes:
NA: Sampling not required for this parameter or well dry.

WBSP-15-05
SUMMARY OF 2015-2020 ANALYTICAL RESULTS
Indiana-Kentucky Electric Corporation
Clifty Creek Station
Madison, Indiana

Parameter	Units	Aug-17	Mar-18	Oct-18	Mar-19	Oct-19	Mar-20
Appendix III Constituents							
Boron, B	mg/L	0.107	3.14	3.19	3.6	3	3.2
Calcium, Ca	mg/L	28.9	123	119	130	130	140
Chloride, Cl	mg/L	60.3	62.7	60.2	60	59	64
Fluoride, F	mg/L	0.17	0.17	0.16	0.15	0.16	0.15
pH	s.u.	6.92	7.02	7.48	7.41	7.75	7.05
Sulfate, SO4	mg/L	229	240	235	250	240	210
Total Dissolved Solids (TDS)	mg/L	498	560	562	600	600	590
Appendix IV Constituents							
Antimony, Sb	ug/L	0.04 J	NA	NA	NA	NA	NA
Arsenic, As	ug/L	2.65	NA	NA	NA	NA	NA
Barium, Ba	ug/L	111	NA	NA	NA	NA	NA
Beryllium, Be	ug/L	0.02 U	NA	NA	NA	NA	NA
Cadmium, Cd	ug/L	0.02	NA	NA	NA	NA	NA
Chromium, Cr	ug/L	0.113	NA	NA	NA	NA	NA
Cobalt, Co	ug/L	1.13	NA	NA	NA	NA	NA
Fluoride, F	mg/L	0.17	NA	NA	NA	NA	NA
Lithium, Li	mg/L	0.001 U	NA	NA	NA	NA	NA
Lead, Pb	ug/L	0.024	NA	NA	NA	NA	NA
Mercury, Hg	ug/L	0.005 U	NA	NA	NA	NA	NA
Molybdenum, Mo	ug/L	82.4	NA	NA	NA	NA	NA
Radium 226 & 228 (combined)	pCi/L	1.351	NA	NA	NA	NA	NA
Selenium, Se	ug/L	0.1 U	NA	NA	NA	NA	NA
Thallium, Tl	ug/L	0.01 J	NA	NA	NA	NA	NA

Notes:
NA: Sampling not required for this parameter or well dry.

WBSP-15-06
SUMMARY OF 2015-2020 ANALYTICAL RESULTS
Indiana-Kentucky Electric Corporation
Clifty Creek Station
Madison, Indiana

Parameter	Units	Jan-16	Mar-16	May-16	Jul-16	Aug-16	Nov-16	Feb-17	Jun-17
Appendix III Constituents									
Boron, B	mg/L	2.74	2.64	2.79	2.91	2.72	2.89	0.042	2.72
Calcium, Ca	mg/L	103	101	113	119	122	122	55.4	111
Chloride, Cl	mg/L	47.2	49.3	58.3	62.7	64.1	69.5	70	75.5
Fluoride, F	mg/L	0.14	0.2 U	0.19	0.15	0.1 J	0.14	0.16	0.15
pH	s.u.	7.82	7.61	8.02	7.9	7.25	7.94	7.78	6.95
Sulfate, SO4	mg/L	196	197	215	220	217	214	224	225
Total Dissolved Solids (TDS)	mg/L	476	506	504	536	540	508	530	589
Appendix IV Constituents									
Antimony, Sb	ug/L	0.25	0.1	0.04 J	0.04 J	0.11	0.04 J	0.07	0.06
Arsenic, As	ug/L	3.31	3.01	0.27	2.1	2.3	2.04	2.27	1.83
Barium, Ba	ug/L	90.6	76.8	73.7	64.7	63.9	64.4	63.5	63.6
Beryllium, Be	ug/L	0.017	0.02 U	0.02 U	0.02 U	0.02 J	0.006 J	0.01 J	0.021
Cadmium, Cd	ug/L	0.05 U	0.06	0.02	0.04	0.07	0.03	0.05	0.08
Chromium, Cr	ug/L	0.7	0.1	0.3	0.2	0.8	0.158	0.631	0.654
Cobalt, Co	ug/L	2.61	3.09	2.51	2.51	2.97	2.56	2.56	2.31
Fluoride, F	mg/L	0.14	0.2 U	0.19	0.15	0.1 J	0.14	0.16	0.15
Lithium, Li	mg/L	0.005 U	0.005	0.001 U	0.002	0.004	0.002	0.001 U	0.002
Lead, Pb	ug/L	0.456	0.085	0.062	0.109	0.684	0.089	0.448	0.575
Mercury, Hg	ug/L	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.004 J	0.005 U	0.694
Molybdenum, Mo	ug/L	86.6	85.9	83.6	78.9	77.2	79.2	74.7	71.5
Radium 226 & 228 (combined)	pCi/L	0.428 U	0.291 U	0.4065	1.4354	0.30378	0.736	1.261	2.801
Selenium, Se	ug/L	0.1 U	0.03 J	0.08 J	0.1 U	0.2 J	0.04 J	0.06 J	0.1
Thallium, Tl	ug/L	0.02 U	0.05 U	0.05 U	0.02 J	0.04 J	0.07	0.05 J	0.03 J

Notes:
NA: Sampling not required for this parameter or well dry.

WBSP-15-06
SUMMARY OF 2015-2020 ANALYTICAL RESULTS
Indiana-Kentucky Electric Corporation
Clifty Creek Station
Madison, Indiana

Parameter	Units	Aug-17	Mar-18	Oct-18	Mar-19	Oct-19	Mar-20
Appendix III Constituents							
Boron, B	mg/L	2.78	2.37	2.81	3.8	3.8	3.8
Calcium, Ca	mg/L	117	102	111	140	130	130
Chloride, Cl	mg/L	75.2	56	80.1	84	86	80
Fluoride, F	mg/L	0.15	0.18	0.18	0.16	0.19	0.18
pH	s.u.	7.47	7.32	7.3	7.34	7.73	7.09
Sulfate, SO4	mg/L	232	141	216	260	220	250
Total Dissolved Solids (TDS)	mg/L	534	454	564	630	620	600
Appendix IV Constituents							
Antimony, Sb	ug/L	0.04 J	NA	NA	NA	NA	NA
Arsenic, As	ug/L	1.39	NA	NA	NA	NA	NA
Barium, Ba	ug/L	61.3	NA	NA	NA	NA	NA
Beryllium, Be	ug/L	0.01 J	NA	NA	NA	NA	NA
Cadmium, Cd	ug/L	0.09	NA	NA	NA	NA	NA
Chromium, Cr	ug/L	0.295	NA	NA	NA	NA	NA
Cobalt, Co	ug/L	2.32	NA	NA	NA	NA	NA
Fluoride, F	mg/L	0.15	NA	NA	NA	NA	NA
Lithium, Li	mg/L	0.007	NA	NA	NA	NA	NA
Lead, Pb	ug/L	0.274	NA	NA	NA	NA	NA
Mercury, Hg	ug/L	0.005 U	NA	NA	NA	NA	NA
Molybdenum, Mo	ug/L	79.8	NA	NA	NA	NA	NA
Radium 226 & 228 (combined)	pCi/L	0.789	NA	NA	NA	NA	NA
Selenium, Se	ug/L	0.06 J	NA	NA	NA	NA	NA
Thallium, Tl	ug/L	0.03 J	NA	NA	NA	NA	NA

Notes:
NA: Sampling not required for this parameter or well dry.

WBSP-15-07
SUMMARY OF 2015-2020 ANALYTICAL RESULTS
Indiana-Kentucky Electric Corporation
Clifty Creek Station
Madison, Indiana

Parameter	Units	Jan-16	Mar-16	May-16	Jul-16	Aug-16	Nov-16	Feb-17	Jun-17
Appendix III Constituents									
Boron, B	mg/L	0.093	0.057	0.031	0.044	0.032	0.043	0.863	0.061
Calcium, Ca	mg/L	137	143	166	178	179	171	258	179
Chloride, Cl	mg/L	16.1	15.8	13.9	12.7	12.7	12.6	11.6	12.6
Fluoride, F	mg/L	0.25 U	0.28	0.31	0.3	0.33	0.24	0.31	0.28
pH	s.u.	7.54	6.93	7.01	7.07	6.62	7.07	7.65	7.7
Sulfate, SO4	mg/L	52.6	39.7	33.4	28.2	25	14.9	9.8	6.3
Total Dissolved Solids (TDS)	mg/L	754	760	750	742	728	718	748	771
Appendix IV Constituents									
Antimony, Sb	ug/L	0.37	0.44	0.14	0.1	0.09	0.21	0.3	0.1
Arsenic, As	ug/L	2.83	8.31	8.46	11.8	18.2	29.4	21.5	35.9
Barium, Ba	ug/L	196	231	225	224	284	375	378	551
Beryllium, Be	ug/L	0.02	0.021	0.028	0.008 J	0.02 J	0.008 J	0.021	0.004 J
Cadmium, Cd	ug/L	0.05 U	0.03	0.01 J	0.008 J	0.01 J	0.01 J	0.008 J	0.02 U
Chromium, Cr	ug/L	0.2	0.4	0.5	0.2	0.4	0.238	0.667	0.11
Cobalt, Co	ug/L	2.58	4.03	4.87	4.4	5.92	6.86	5.87	5.03
Fluoride, F	mg/L	0.25 U	0.28	0.31	0.3	0.33	0.24	0.31	0.28
Lithium, Li	mg/L	0.005 U	0.016	0.002	0.003	0.006	0.001 J	0.006	0.008
Lead, Pb	ug/L	0.233	0.336	0.326	0.092	0.264	0.092	0.34	0.178
Mercury, Hg	ug/L	0.005 U	0.002 J	0.005 U	0.005 U	0.005 U	0.003 J	0.005 U	1.01
Molybdenum, Mo	ug/L	10.1	10.5	7.28	6.85	8.88	12	9.48	9.39
Radium 226 & 228 (combined)	pCi/L	0.399 U	0.899	1.585	2.178	0.761	0.901	1.606	15.37
Selenium, Se	ug/L	0.3	0.3	0.1	0.1	0.2	0.2	0.2	0.3
Thallium, Tl	ug/L	0.04	0.03 J	0.03 J	0.02 J	0.02 J	0.02 J	0.052	0.02 J

Notes:
NA: Sampling not required for this parameter or well dry.

WBSP-15-07
SUMMARY OF 2015-2020 ANALYTICAL RESULTS
Indiana-Kentucky Electric Corporation
Clifty Creek Station
Madison, Indiana

Parameter	Units	Aug-17	Mar-18	Oct-18	Mar-19	Oct-19	Mar-20
Appendix III Constituents							
Boron, B	mg/L	0.051	0.003 J	0.05 J	0.025 J	0.1 U	0.1 U
Calcium, Ca	mg/L	183	167	176	200	180	180
Chloride, Cl	mg/L	12.7	12.9	12.5	13	11	12
Fluoride, F	mg/L	0.29	0.37	0.32	0.33	0.27	0.29
pH	s.u.	7.27	6.95	6.75	6.82	6.95	6.75
Sulfate, SO4	mg/L	4.7	2.5	3.9	15	23	14
Total Dissolved Solids (TDS)	mg/L	752	777	770	840	760	740
Appendix IV Constituents							
Antimony, Sb	ug/L	0.12	NA	NA	NA	NA	NA
Arsenic, As	ug/L	29.9	NA	NA	NA	NA	NA
Barium, Ba	ug/L	561	NA	NA	NA	NA	NA
Beryllium, Be	ug/L	0.02 J	NA	NA	NA	NA	NA
Cadmium, Cd	ug/L	0.01 J	NA	NA	NA	NA	NA
Chromium, Cr	ug/L	0.446	NA	NA	NA	NA	NA
Cobalt, Co	ug/L	4.78	NA	NA	NA	NA	NA
Fluoride, F	mg/L	0.29	NA	NA	NA	NA	NA
Lithium, Li	mg/L	0.007	NA	NA	NA	NA	NA
Lead, Pb	ug/L	0.328	NA	NA	NA	NA	NA
Mercury, Hg	ug/L	0.005 U	NA	NA	NA	NA	NA
Molybdenum, Mo	ug/L	10.3	NA	NA	NA	NA	NA
Radium 226 & 228 (combined)	pCi/L	1.66	NA	NA	NA	NA	NA
Selenium, Se	ug/L	0.4	NA	NA	NA	NA	NA
Thallium, Tl	ug/L	0.057	NA	NA	NA	NA	NA

Notes:
NA: Sampling not required for this parameter or well dry.

WBSP-15-08
SUMMARY OF 2015-2020 ANALYTICAL RESULTS
Indiana-Kentucky Electric Corporation
Clifty Creek Station
Madison, Indiana

Parameter	Units	Jan-16	Mar-16	May-16	Jul-16	Aug-16	Nov-16	Feb-17
Appendix III Constituents								
Boron, B	mg/L	0.039	0.042	0.021	0.041	0.043	0.027	0.03
Calcium, Ca	mg/L	88.1	79.6	83.2	87.3	85.6	83.1	79.2
Chloride, Cl	mg/L	15.4	16.5	16	16.5	16	15.8	15.3
Fluoride, F	mg/L	0.25 U	0.2 U	0.23	0.18	0.21	0.1 J	0.24
pH	s.u.	6.85	6.5	6.83	6.87	6.49	6.62	6.48
Sulfate, SO4	mg/L	1 U	0.2 J	0.2 J	0.1 U	0.2 U	0.2 U	0.2 U
Total Dissolved Solids (TDS)	mg/L	356	440	364	394	348	324	280
Appendix IV Constituents								
Antimony, Sb	ug/L	0.23	0.13	0.09	0.08	0.1 J	0.14	0.11
Arsenic, As	ug/L	51.3	65.6	69.3	71.9	76.8	72.7	59.7
Barium, Ba	ug/L	368	395	466	393	386	387	333
Beryllium, Be	ug/L	0.064	0.081	0.052	0.098	0.059	0.068	0.068
Cadmium, Cd	ug/L	0.05 U	0.02	0.02 J	0.04	0.02 J	0.02 J	0.02
Chromium, Cr	ug/L	1.4	1.8	1	1.1	1.4	1.41	1.39
Cobalt, Co	ug/L	4.1	2.7	1.75	2.18	1.83	1.83	1.95
Fluoride, F	mg/L	0.25 U	0.2 U	0.23	0.18	0.21	0.1 J	0.24
Lithium, Li	mg/L	0.005 U	0.002 J	0.001 U	0.001 U	0.003	0.001 U	0.001 U
Lead, Pb	ug/L	1.41	1.47	0.905	2.72	1.13	1.18	1.24
Mercury, Hg	ug/L	0.005 U	0.002 J	0.005 U	0.003 J	0.005 U	0.004 J	0.003 J
Molybdenum, Mo	ug/L	4.66	2.24	1.44	0.82	1.75	1.83	1.25
Radium 226 & 228 (combined)	pCi/L	0.246 U	0.821 U	1.212	2.995	0.521	1.949	1.044
Selenium, Se	ug/L	0.3	0.4	0.3	0.4	0.4	0.3	0.3
Thallium, Tl	ug/L	0.02 U	0.02 J	0.02 J	0.02 J	0.1 U	0.03 J	0.02 J

Notes:
NA: Sampling not required for this parameter or well dry.

WBSP-15-08
SUMMARY OF 2015-2020 ANALYTICAL RESULTS
Indiana-Kentucky Electric Corporation
Clifty Creek Station
Madison, Indiana

Parameter	Units	Jun-17	Aug-17	Mar-18	Oct-18	Mar-19	Oct-19	Mar-20
Appendix III Constituents								
Boron, B	mg/L	0.083	0.113	0.005 U	0.132	0.027 J	0.028 J	0.1 U
Calcium, Ca	mg/L	73.9	77	74.6	72.2	78	80	85
Chloride, Cl	mg/L	16	16.3	16.5	16.6	17	16	16
Fluoride, F	mg/L	0.22	0.2	0.26	0.19	0.16	0.19	0.19
pH	s.u.	8.03	7.92	7.08	6.35	6.42	7.89	7.05
Sulfate, SO4	mg/L	0.2 U	0.2 U	0.2	0.4 U	8.1	1.8	4
Total Dissolved Solids (TDS)	mg/L	368	340	380	336	350	340	330
Appendix IV Constituents								
Antimony, Sb	ug/L	0.07	0.07	NA	NA	NA	NA	NA
Arsenic, As	ug/L	79.2	75.8	NA	NA	NA	NA	NA
Barium, Ba	ug/L	383	362	NA	NA	NA	NA	NA
Beryllium, Be	ug/L	0.03	0.02 J	NA	NA	NA	NA	NA
Cadmium, Cd	ug/L	0.008 J	0.02 U	NA	NA	NA	NA	NA
Chromium, Cr	ug/L	0.675	0.607	NA	NA	NA	NA	NA
Cobalt, Co	ug/L	1.48	1.36	NA	NA	NA	NA	NA
Fluoride, F	mg/L	0.22	0.2	NA	NA	NA	NA	NA
Lithium, Li	mg/L	0.008	0.006	NA	NA	NA	NA	NA
Lead, Pb	ug/L	0.457	0.232	NA	NA	NA	NA	NA
Mercury, Hg	ug/L	1.04	0.005 U	NA	NA	NA	NA	NA
Molybdenum, Mo	ug/L	0.94	2.03	NA	NA	NA	NA	NA
Radium 226 & 228 (combined)	pCi/L	1.223	0.7782	NA	NA	NA	NA	NA
Selenium, Se	ug/L	0.2	0.3	NA	NA	NA	NA	NA
Thallium, Tl	ug/L	0.05 U	0.05 U	NA	NA	NA	NA	NA

Notes:
NA: Sampling not required for this parameter or well dry.

WBSP-15-09
SUMMARY OF 2015-2020 ANALYTICAL RESULTS
Indiana-Kentucky Electric Corporation
Clifty Creek Station
Madison, Indiana

Parameter	Units	Jan-16	Mar-16	May-16	Jul-16	Aug-16	Nov-16	Feb-17
Appendix III Constituents								
Boron, B	mg/L	0.014	0.048	0.006	0.021	0.023	0.031	0.124
Calcium, Ca	mg/L	62.2	75	50	47.7	49.9	51.1	47.4
Chloride, Cl	mg/L	4.94	4.78	3.57	3.26	3.12	3.2	3.98
Fluoride, F	mg/L	0.33	0.32	0.32	0.38	0.31	0.33	0.25
pH	s.u.	6.62	6.81	6.78	7.38	6.51	6.75	7.05
Sulfate, SO4	mg/L	4.5	6.2	3.8	4	3.6	1.8	282
Total Dissolved Solids (TDS)	mg/L	248	244	280	176	230	200	728
Appendix IV Constituents								
Antimony, Sb	ug/L	0.41	0.1	0.15	0.09	0.05 J	0.15	0.04 J
Arsenic, As	ug/L	7.35	5.88	21.6	26.5	19.1	20.4	25.4
Barium, Ba	ug/L	157	193	209	222	194	204	189
Beryllium, Be	ug/L	0.039	0.009 J	0.022	0.025	0.01 J	0.01 J	0.02 J
Cadmium, Cd	ug/L	0.05 J	0.04	0.01 J	0.05	0.02 J	0.005 J	0.006 J
Chromium, Cr	ug/L	0.4	0.2	0.6	0.8	0.3	0.358	0.479
Cobalt, Co	ug/L	2.57	6.06	3.79	3.8	3.24	3.25	2
Fluoride, F	mg/L	0.33	0.32	0.32	0.38	0.31	0.33	0.25
Lithium, Li	mg/L	0.004 J	0.005 U	0.001 U	0.024	0.001 U	0.001 U	0.014
Lead, Pb	ug/L	0.291	0.127	0.326	0.522	0.164	0.179	0.238
Mercury, Hg	ug/L	0.005 U	0.005 U	0.005 U	0.2 U	0.005 U	0.004 J	0.005 U
Molybdenum, Mo	ug/L	2.66	3.39	4.92	6.49	4.89	12.4	4.66
Radium 226 & 228 (combined)	pCi/L	0.114	0.426 U	0.448	0.663	1.047	0.4799	NA
Selenium, Se	ug/L	0.1	0.1	0.2	0.1	0.2 J	0.1	0.06 J
Thallium, Tl	ug/L	0.01 J	0.03 J	0.02 J	0.05 J	0.1 U	0.02 J	0.05 U

Notes:
NA: Sampling not required for this parameter or well dry.

WBSP-15-09
SUMMARY OF 2015-2020 ANALYTICAL RESULTS
Indiana-Kentucky Electric Corporation
Clifty Creek Station
Madison, Indiana

Parameter	Units	Jun-17	Aug-17	Mar-18	Oct-18	Mar-19	Oct-19	Mar-20
Appendix III Constituents								
Boron, B	mg/L	0.07	0.048	0.054	0.291	0.042 J	0.038 J	0.091 J
Calcium, Ca	mg/L	44.6	48.6	48.6	56	48	53	47
Chloride, Cl	mg/L	2.23	2.52	3.35	2.05	1.7	2.4	2.5
Fluoride, F	mg/L	0.32	0.38	0.22	0.43	0.32	0.47	0.46
pH	s.u.	7.77	7.3	7.22	6.48	6.71	7.49	7.95
Sulfate, SO4	mg/L	0.2 J	0.5	55.3	4.7	17	5.7	2.7
Total Dissolved Solids (TDS)	mg/L	223	206	221	239	210	240	200
Appendix IV Constituents								
Antimony, Sb	ug/L	0.04 J	0.05 J	NA	NA	NA	NA	NA
Arsenic, As	ug/L	28.1	19.5	NA	NA	NA	NA	NA
Barium, Ba	ug/L	192	183	NA	NA	NA	NA	NA
Beryllium, Be	ug/L	0.01 J	0.01 J	NA	NA	NA	NA	NA
Cadmium, Cd	ug/L	0.005 J	0.02 J	NA	NA	NA	NA	NA
Chromium, Cr	ug/L	0.26	0.4	NA	NA	NA	NA	NA
Cobalt, Co	ug/L	1.58	1.47	NA	NA	NA	NA	NA
Fluoride, F	mg/L	0.32	0.38	NA	NA	NA	NA	NA
Lithium, Li	mg/L	0.004	0.005	NA	NA	NA	NA	NA
Lead, Pb	ug/L	0.135	0.21	NA	NA	NA	NA	NA
Mercury, Hg	ug/L	0.668	0.005 U	NA	NA	NA	NA	NA
Molybdenum, Mo	ug/L	3.39	5.65	NA	NA	NA	NA	NA
Radium 226 & 228 (combined)	pCi/L	1.443	0.708	NA	NA	NA	NA	NA
Selenium, Se	ug/L	0.1	0.1	NA	NA	NA	NA	NA
Thallium, Tl	ug/L	0.05 U	0.05 U	NA	NA	NA	NA	NA

Notes:
NA: Sampling not required for this parameter or well dry.

WBSP-15-10
SUMMARY OF 2015-2020 ANALYTICAL RESULTS
Indiana-Kentucky Electric Corporation
Clifty Creek Station
Madison, Indiana

Parameter	Units	Jan-16	Mar-16	May-16	Jul-16	Aug-16	Nov-16	Feb-17
Appendix III Constituents								
Boron, B	mg/L	0.023	0.058	0.018	0.032	0.08	0.055	0.088
Calcium, Ca	mg/L	85.3	75.2	91.4	87.8	94.8	88.2	75.9
Chloride, Cl	mg/L	18.3	19.8	21	21	21.1	20.8	20.6
Fluoride, F	mg/L	0.2 J	0.25	0.27	0.28	0.23	0.24	0.25
pH	s.u.	6.73	6.88	6.82	7.4	6.65	6.72	7.11
Sulfate, SO4	mg/L	61.4	51.5	41	43.1	58.6	45.1	35.3
Total Dissolved Solids (TDS)	mg/L	350	400	370	376	370	328	314
Appendix IV Constituents								
Antimony, Sb	ug/L	0.23	0.17	0.2	0.29	0.16	0.21	0.15
Arsenic, As	ug/L	1.73	4.27	8.35	5.52	3.66	12.5	6.92
Barium, Ba	ug/L	196	203	225	198	208	273	216
Beryllium, Be	ug/L	0.032	0.041	0.077	0.037	0.02 J	0.306	0.077
Cadmium, Cd	ug/L	0.06	0.04	0.03	0.03	0.03 J	0.1	0.03
Chromium, Cr	ug/L	0.3	0.8	1.2	0.9	0.4	6.45	1.84
Cobalt, Co	ug/L	2.81	2.68	3.18	2.19	2.17	6.47	2.39
Fluoride, F	mg/L	0.2 J	0.25	0.27	0.28	0.23	0.24	0.25
Lithium, Li	mg/L	0.003 J	0.005 U	0.001 U	0.004	0.003	0.013	0.016
Lead, Pb	ug/L	0.342	0.455	1.04	0.622	0.392	4.91	0.943
Mercury, Hg	ug/L	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.011	0.002 J
Molybdenum, Mo	ug/L	2.51	3.84	3.58	4.52	16.4	29.9	3.86
Radium 226 & 228 (combined)	pCi/L	0.0206	0.857 U	0.288	1.374	1.274	1.336	0.6692
Selenium, Se	ug/L	0.1	0.1	0.3	0.1	0.1 J	0.9	0.2
Thallium, Tl	ug/L	0.01 J	0.04 J	0.02 J	0.02 J	0.02 J	0.095	0.03 J

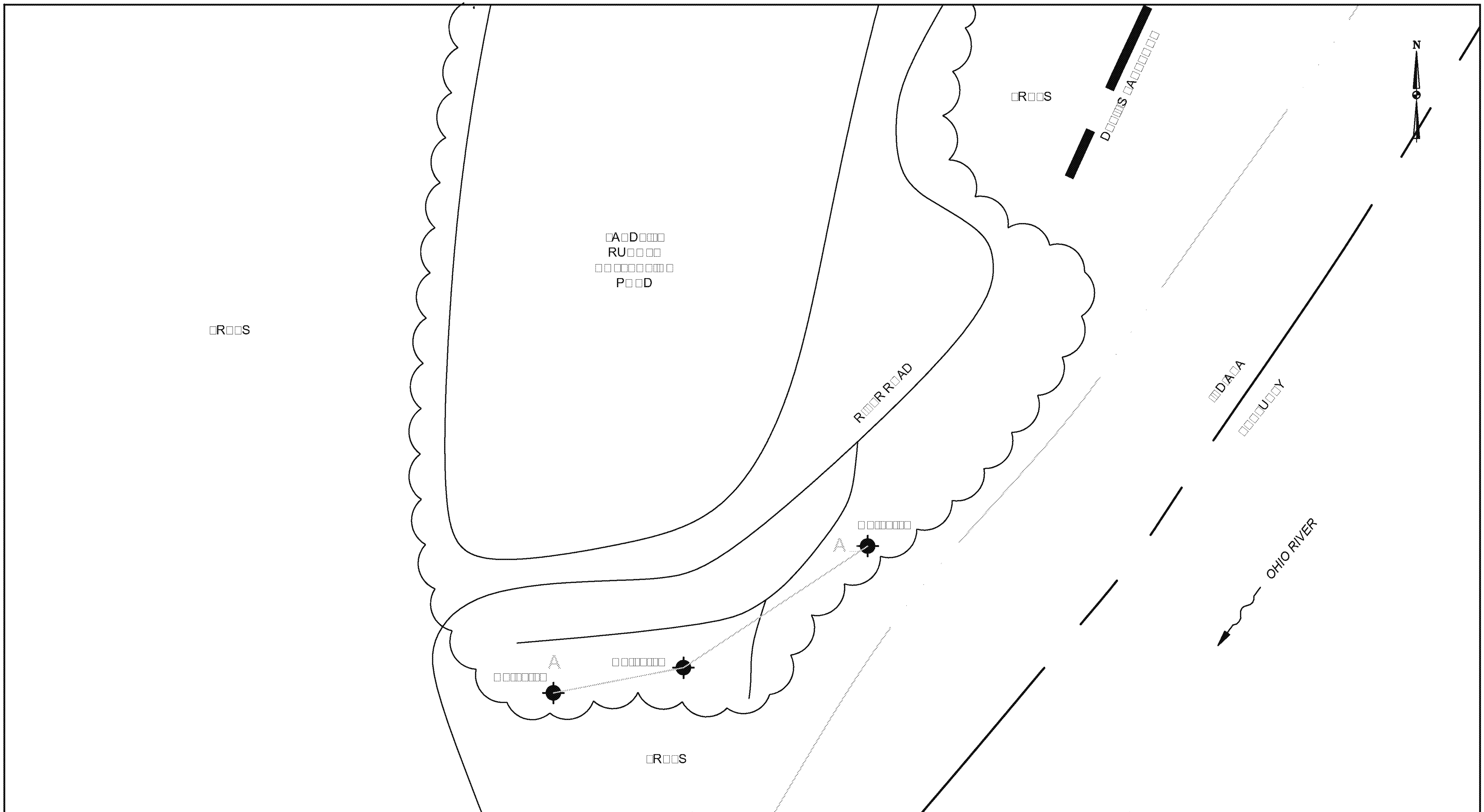
Notes:
NA: Sampling not required for this parameter or well dry.

WBSP-15-10
SUMMARY OF 2015-2020 ANALYTICAL RESULTS
Indiana-Kentucky Electric Corporation
Clifty Creek Station
Madison, Indiana

Parameter	Units	Jun-17	Aug-17	Mar-18	Oct-18	Mar-19	Oct-19	Mar-20
Appendix III Constituents								
Boron, B	mg/L	0.111	0.061	0.005 U	0.16	0.037 J	0.03 J	0.024 J
Calcium, Ca	mg/L	66.1	72.6	70.4	78.6	71	67	68
Chloride, Cl	mg/L	21	21.3	24	20.9	22	21	22
Fluoride, F	mg/L	0.25	0.25	0.28	0.29	0.28	0.29	0.3
pH	s.u.	7.49	7.53	6.95	6.39	6.98	7.38	7.42
Sulfate, SO4	mg/L	38.6	37.1	44.7	38.8	44	38	40
Total Dissolved Solids (TDS)	mg/L	328	288	329	316	310	30	310
Appendix IV Constituents								
Antimony, Sb	ug/L	0.15	0.14	NA	NA	NA	NA	NA
Arsenic, As	ug/L	10.6	7.27	NA	NA	NA	NA	NA
Barium, Ba	ug/L	292	236	NA	NA	NA	NA	NA
Beryllium, Be	ug/L	0.276	0.071	NA	NA	NA	NA	NA
Cadmium, Cd	ug/L	0.11	0.03	NA	NA	NA	NA	NA
Chromium, Cr	ug/L	5.63	1.75	NA	NA	NA	NA	NA
Cobalt, Co	ug/L	5.67	2.59	NA	NA	NA	NA	NA
Fluoride, F	mg/L	0.25	0.25	NA	NA	NA	NA	NA
Lithium, Li	mg/L	0.011	0.009	NA	NA	NA	NA	NA
Lead, Pb	ug/L	4.56	1.1	NA	NA	NA	NA	NA
Mercury, Hg	ug/L	1.2	0.005 U	NA	NA	NA	NA	NA
Molybdenum, Mo	ug/L	2.7	5.6	NA	NA	NA	NA	NA
Radium 226 & 228 (combined)	pCi/L	0.2395	0.859	NA	NA	NA	NA	NA
Selenium, Se	ug/L	1	0.2	NA	NA	NA	NA	NA
Thallium, Tl	ug/L	0.069	0.03 J	NA	NA	NA	NA	NA

Notes:
NA: Sampling not required for this parameter or well dry.

APPENDIX E4 – STRATIGRAPHIC CROSS-SECTIONS



LEGEND:

MONITORING WELL LOCATION

200' 0' 200' 400'

SCALE: 1"= 200'

DRAWN BY	JM
DATE	
CHECKED BY	
JOB NO.	CLIFTY
DWG FILE	GC--IKEC_Clifty_XSEC LOCS_LRCP.dwg
DRAWING SCALE	AS SHOWN

AGES

Applied Geology And Environmental Science, Inc.

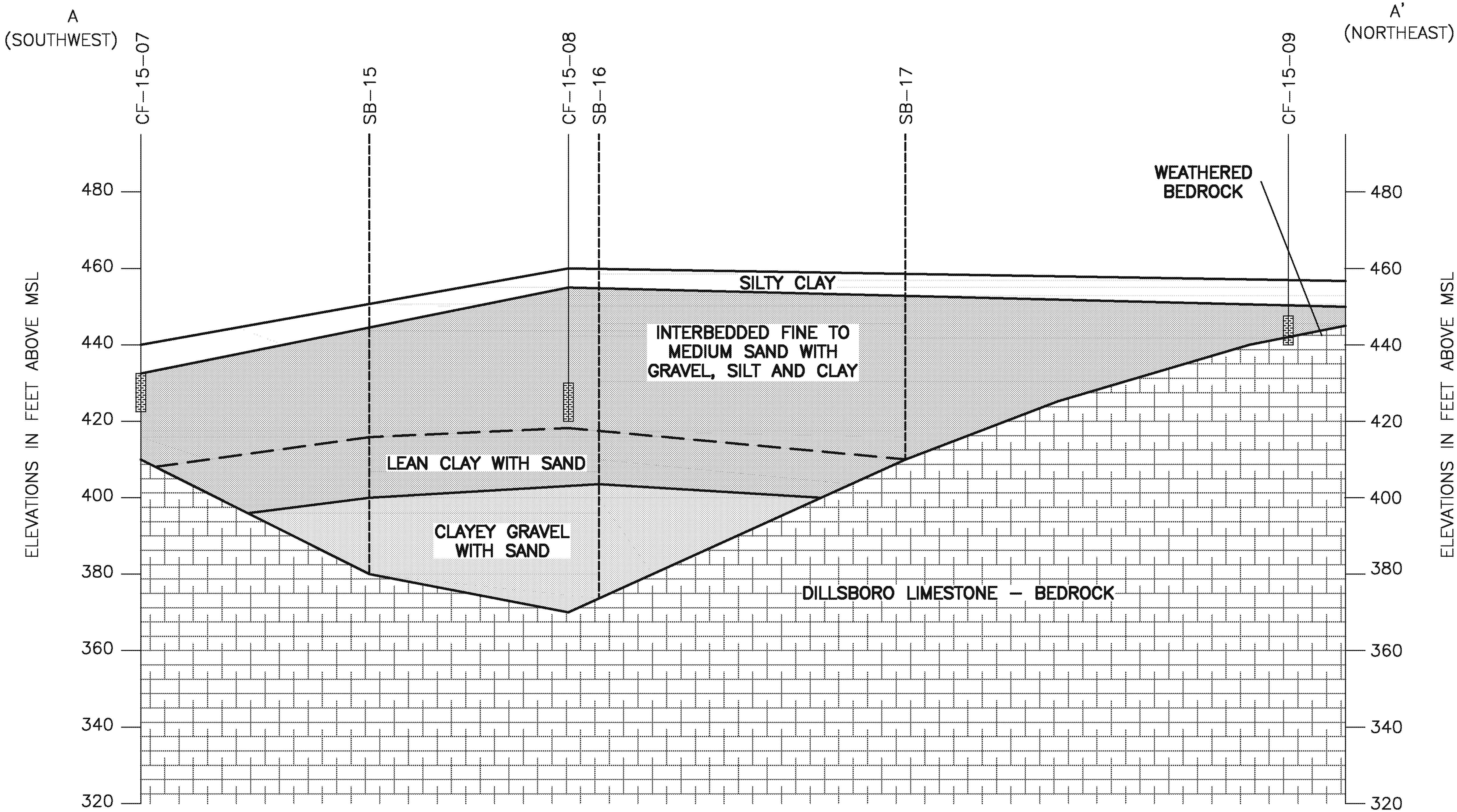
INDIANA–KENTUCKY ELECTRIC CORPORATION

CLIFTY CREEK STATION
MADISON, INDIANA
TYPE I RESIDUAL WASTE LANDFILL AND
LANDFILL RUNOFF COLLECTION POND
LOCATION OF GENERALIZED GEOLOGIC CROSS-SECTION A-A'

DRAWING NAME

REV. 0

Plot: 10/12/2020 16:37 \GC_xsections_10-12-20\GC--IKEC_Clifty_XSEC LOCS_LRCP



NOTES:

1) CROSS-SECTION COMPILED USING AGES BORING AND WELL LOGS, SOIL BORING INFORMATION FROM THE 2007 LITIGATION REPORT AND STANTEC DATA FROM THE LRCP STABILITY ASSESSMENT REPORT.

DRAWN BY	JM
DATE	
CHECKED BY	
JOB NO.	CLIFTY
DWG FILE	GC--IKEC_Clifty_LRCP_Cross Sec.dwg
DRAWING SCALE	NOT TO SCALE

AGES
Applied Geology And Environmental Science, Inc.

INDIANA-KENTUCKY ELECTRIC CORPORATION

CLIFTY CREEK STATION
MADISON, INDIANA
LANDFILL RUNOFF COLLECTION POND
GENERALIZED GEOLOGIC CROSS-SECTION A-A'

DRAWING NAME | REV. 0

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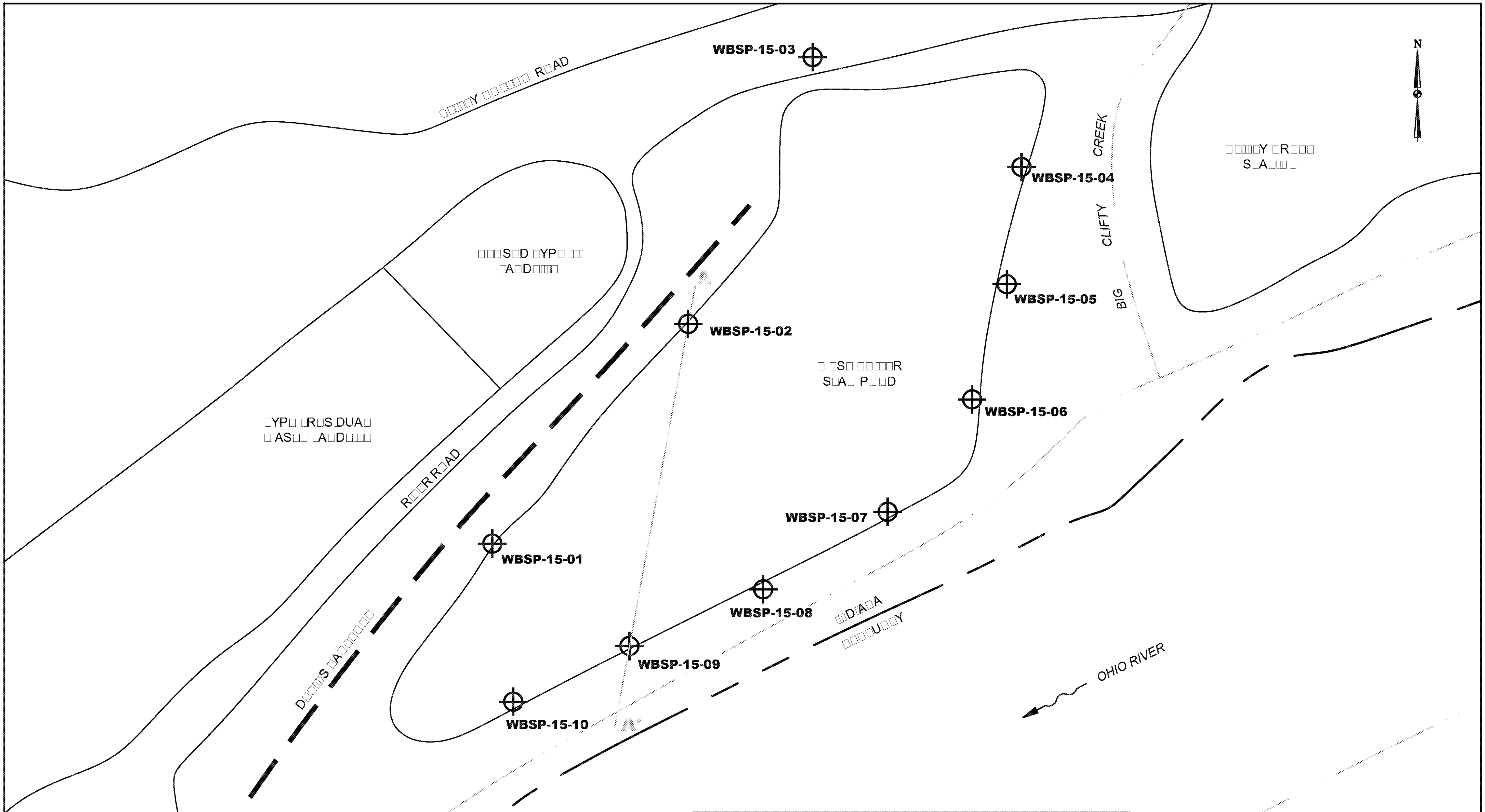

LEGEND:

MONITORING WELL LOCATION

400' 0' 400' 800'

SCALE: 1"= 400'

DRAWN BY	JM
DATE	
CHECKED BY	
JOB NO.	CLIFTY
DWG FILE	GC--IKEC_Clifty_XSEC LOCS_WBSP.dwg
DRAWING SCALE	AS SHOWN

AGES
Applied Geology And Environmental Science, Inc.

INDIANA–KENTUCKY ELECTRIC CORPORATION

CLIFTY CREEK STATION
MADISON, INDIANA
WEST BOILER SLAG POND
LOCATION OF GENERALIZED GEOLOGIC CROSS-SECTION A–A'

DRAWING NAME

REV. 0

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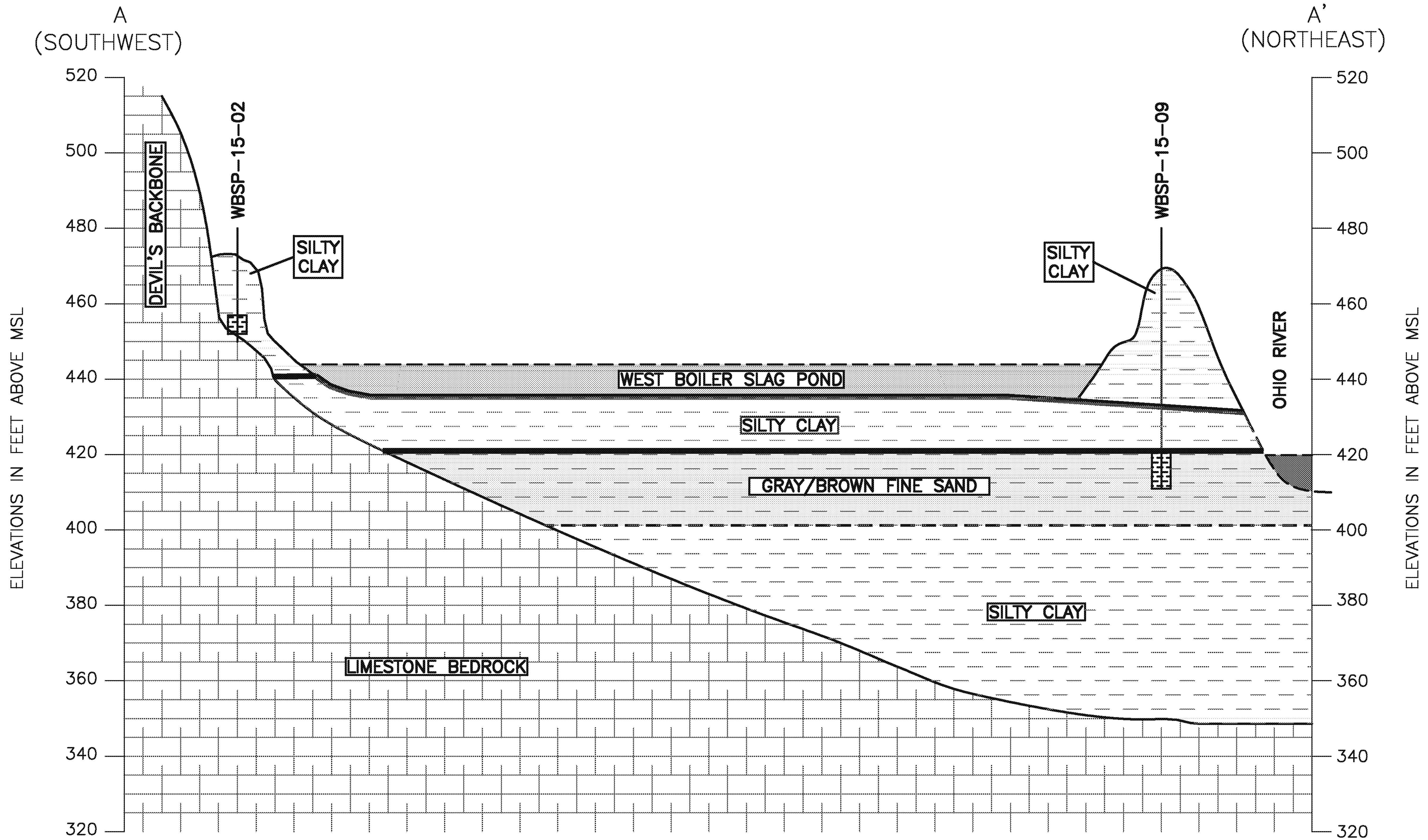

DRAWN BY	JM
DATE	
CHECKED BY	
JOB NO.	CLIFTY
DWG FILE	GC--IKEC_Clifty_WBSP_Cross Sec.dwg
DRAWING SCALE	NOT TO SCALE

AGES
Applied Geology And Environmental Science, Inc.

INDIANA-KENTUCKY ELECTRIC CORPORATION

CLIFTY CREEK STATION
MADISON, INDIANA
WEST BOILER SLAG POND
GENERALIZED GEOLOGIC CROSS-SECTION A-A'

DRAWING NAME

REV. 0

Plot: 10/12/2020 16:12 \GC_xsections_10-12-20\GC--IKEC_Clifty_WBSP_Cross Sec.dwg

APPENDIX E5 – ASSESSMENT OF CORRECTIVE MEASURES REPORT (LRCP)

OVEC/IKEC

OHIO VALLEY ELECTRIC CORPORATION
INDIANA-KENTUCKY ELECTRIC CORPORATION
3932 U. S. Route 23
P. O. Box 468
Piketon, Ohio 45661
740-289-7200

WRITER'S DIRECT DIAL NO:
740-897-7768

September 19, 2019

CERTIFIED MAIL
RETURN RECEIPT REQUESTED

Mr. Bruno Pigott, Commissioner
Indiana Department of Environmental Management
100 N. Senate Avenue
Mail Code 50-01
Indianapolis, IN 46204-2251

Dear Mr. Pigott:

Re: Indiana-Kentucky Electric Corporation
Notification of Availability of Assessment of Corrective Measure Report

As required by 40 CFR 257.106(h)(7), on May 15, 2019, the Indiana-Kentucky Electric Corporation (IKEC) provided notification to the Commissioner of the Indiana Department of Environmental Management that an Assessment of Corrective Measures had been initiated for a confirmed Statistically Significant Increase (SSI) of Appendix IV constituent Molybdenum at Clifty Creek Station's landfill runoff collection pond.

Further, as required by 40 CFR 257.96(d), a report detailing the effectiveness of potential corrective measures was prepared by AGES, Inc. using 40 CFR 257.27 as a basis for the selection of potential remedies. Per 40 CFR 257.106(h)(8), this letter provides notification that the report has been placed in the facility's operating record, as well as on the company's publically accessible internet site and can be viewed at http://www.ovec.com/CCRCompliance.php. Prior to the selection of a remedy, IKEC will host a public meeting as detailed in 40 CFR 257.26(d) to discuss the results of the corrective measures assessment with interested and affected parties.

If you have any questions, or require any additional information, please call me at (740) 897-7768.

Sincerely,

Tim Fulk

Tim Fulk
Engineer II
TLF:klr

Applied Geology And Environmental Science, Inc.

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Clinton, PA 15026
www.appliedgeology.net
P 412. 264. 6453
F 412. 264. 6567

COAL COMBUSTION RESIDUALS REGULATION ASSESSMENT OF CORRECTIVE MEASURES REPORT

LANDFILL RUNOFF COLLECTION POND (LRCP) INDIANA-KENTUCKY ELECTRIC CORPORATION CLIFTY CREEK STATION MADISON, INDIANA

SEPTEMBER 2019

Prepared for:

INDIANA-KENTUCKY ELECTRIC CORPORATION (IKEC)

By:

APPLIED GEOLOGY AND ENVIRONMENTAL SCIENCE, INC.

COAL COMBUSTION RESIDUALS REGULATION
ASSESSMENT OF CORRECTIVE MEASURES REPORT
LANDFILL RUNOFF COLLECTION POND (LRCP)
INDIANA-KENTUCKY ELECTRIC CORPORATION
CLIFTY CREEK STATION
MADISON, INDIANA

SEPTEMBER 2019

Prepared for:

INDIANA-KENTUCKY ELECTRIC CORPORATION (IKEC)

Prepared By:

APPLIED GEOLOGY AND ENVIRONMENTAL SCIENCE, INC.

Bethany Flaherty

Bethany Flaherty
Senior Scientist I

Robert W. King

Robert W. King, P.G.
President/Chief Hydrogeologist

COAL COMBUSTION RESIDUALS REGULATION
ASSESSMENT OF CORRECTIVE MEASURES REPORT
LANDFILL RUNOFF COLLECTION POND (LRCP)
INDIANA-KENTUCKY ELECTRIC CORPORATION
CLIFTY CREEK STATION
MADISON, INDIANA

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LIST OF ACRONYMS

°C	Degrees Celsius
ACM	Assessment of Corrective Measures
AGES	Applied Geology and Environmental Science, Inc.
ASD	Alternate Source Demonstration
ASTM	American Society for Testing and Materials
bgs	Below Ground Surface
CCR	Coal Combustion Residuals
ft/day	Feet per Day
ft/sec	Feet per Second
ft/yr	Feet per Year
GMPP	Groundwater Monitoring Program Plan
gpm	Gallons per minute
GWPS	Groundwater Protection Standard
IDEM	Indiana Department of Environmental Management
IKEC	Indiana-Kentucky Electric Corporation
K	Hydraulic Conductivity
LRCP	Landfill Runoff Collection Pond
MCL	Maximum Contaminant Level
mg/kg	Milligrams per Kilogram
mm	Millimeter
MNA	Monitored Natural Attenuation
MW	Megawatt
NPDES	National Pollution Discharge Elimination System
NTU	Nephelometric Turbidity Unit
O&M	Operations and Maintenance
ORP	Oxidation Reduction Potential
OVEC	Ohio Valley Electric Corporation
PRB	Permeable Reactive Barrier
PVC	Polyvinyl Chloride
RCRA	Resource Conservation and Recovery Act
SSI	Statistically Significant Increase
Stantec	Stantec Consulting Services, Inc.
StAP	Statistical Analysis Plan
SU	Standard Unit
Type I Landfill	Type I Residual Waste Landfill
U.S. EPA	United States Environmental Protection Agency
ug/L	Micrograms per Liter
WBSP	West Boiler Slag Pond

COAL COMBUSTION RESIDUALS REGULATION
ASSESSMENT OF CORRECTIVE MEASURES REPORT
LANDFILL RUNOFF COLLECTION POND (LRCP)
INDIANA-KENTUCKY ELECTRIC CORPORATION
CLIFTY CREEK STATION
MADISON, INDIANA

1.0 INTRODUCTION

On December 19, 2014, the United States Environmental Protection Agency (U.S. EPA) issued their final Coal Combustion Residuals (CCR) regulation which regulates CCR as a non-hazardous waste under Subtitle D of Resource Conservation and Recovery Act (RCRA) and became effective six (6) months from the date of its publication (April 17, 2015) in the Federal Register, referred to as the "CCR Rule." The rule applies to new and existing landfills, and surface impoundments used to dispose of or otherwise manage CCR generated by electric utilities and independent power producers. Because the rule was promulgated under Subtitle D of RCRA, it does not require regulated facilities to obtain permits, does not require state adoption, and cannot be enforced by U.S. EPA.

The CCR Rule in 40 CFR § 257.96(a) requires that an owner or operator initiate an Assessment of Corrective Measures (ACM) to prevent further release, to remediate any releases, and to restore affected area(s) to original conditions in the event that any Appendix IV constituent has been detected at a Statistically Significant Level (SSL) greater than a Groundwater Protection Standard (GWPS). The ACM must be completed within 90 days after initiation. The CCR Rule allows up to an additional 60 days to complete the ACM if a demonstration shows that more time is needed because of site-specific conditions or circumstances. A certification from a qualified professional engineer attesting that the demonstration is accurate is required. As required by 40 CFR § 257.90(e), the demonstration showing that more time was needed will be included in the 2019 Groundwater Monitoring and Corrective Action Report.

This ACM Report has been prepared to comply with 40 CFR § 257.90(c) of the CCR Rule and documents the results that are the basis for the evaluation of potential corrective measure remedial technologies. This report includes a summary of groundwater monitoring conducted to date, along with the results of site characterization activities. Finally, potential remedial technologies are identified in this report and evaluated against requirements, as specified in the CCR Rule.

2.0 SITE BACKGROUND

The Clifty Creek Station, located in Madison, Indiana, is a 1,304-megawatt (MW) coal-fired generating plant operated by the Indiana-Kentucky Electric Corporation (IKEC), a subsidiary of the Ohio Valley Electric Corporation (OVEC). The Clifty Creek Station has six (6) 217.26-MW generating units and has been in operation since 1955. Beginning in 1955, ash products were sluiced to disposal ponds located in the plant site. During the course of plant operations, CCRs have been managed and disposed of in various units at the station.

There are three (3) CCR units at the Clifty Creek Station (Figure 2-1):

- Type I Residual Waste Landfill (Type I Landfill);
- Landfill Runoff Collection Pond (LRCP); and
- West Boiler Slag Pond (WBSP).

Under the CCR program, IKEC installed a groundwater monitoring system at each unit in accordance with the requirements of the CCR Rule; the Type I Landfill and LRCP are included in a multi-unit monitoring system. From January 2016 through August 2017, nine (9) rounds of background groundwater monitoring were conducted at all of the CCR units. The first round of Detection Monitoring was performed in March 2018. Based on groundwater monitoring conducted to date, no Statistically Significant Increases (SSIs) have been identified for Appendix III constituents at the WBSP. Therefore, this unit has remained in Detection Monitoring under the CCR program.

During the March 2018 Detection Monitoring event, SSIs were identified for the Type I Landfill and LRCP and both entered into Assessment Monitoring in September 2018. Further action was therefore required for both units under the CCR program. Details regarding these efforts are presented in the following sections of this report.

3.0 GEOLOGY AND HYDROGEOLOGY

3.1 Regional Setting

The site lies in the Central Lowland Physiographic Province along the western flanks of the Cincinnati Arch and within the Central Stable Region. The stratigraphic sequence in the regional area consists of widespread discontinuous layers of Quaternary deposits of alluvial and glacial origin overlying sedimentary rocks generally consisting of limestones, dolomites and interbedded shale. The exposed sedimentary rocks range in age from Mississippian to Ordovician. The Quaternary deposits are largely of glacial origin and consist of loess, till and outwash. Glacial outwash is present in nearly all of the stream valleys north of and including the Ohio River valley. The outwash is covered, in some cases, by a veneer of recent alluvial deposits from active streams.

Unconsolidated alluvial sediments deposited along the Ohio River valley, near or adjacent to the river constitute the major aquifer of the region. These deposits are normally found only within the Ohio River valley and the tributary streams north and northeast of the river. Wells installed in this aquifer typically yield 100 to 1,000 gallons per minute (gpm) depending upon their location and construction. The Ohio River valley is incised into Ordovician bedrock. The low permeability bedrock forms the lateral and underlying confinement to the aquifer.

3.2 Unit-Specific Setting

Bedrock beneath the Type I Landfill and LRCP consists of impermeable limestone and shale of the Ordovician Dillsboro formation, which is overlain by approximately 20 feet of clayey gravel with sand (Applied Geology and Environmental Science, Inc. [AGES] 2018a). The clayey gravel with sand is overlain by a lean clay with sand, which is overlain by a fine to medium sand with gravel, silt and clay (Figure 3-1). The uppermost unit in the area is a surficial layer of silty clay. A limestone ridge known as the Devil's Backbone runs northeast to southwest along the length of the Type I Landfill & LRCP (Figure 3-2). The Devil's Backbone acts as an impermeable barrier that forces groundwater passing beneath the Type I Landfill to flow either toward the northeast or toward the southwest (Figure 3-3).

Based on historic aquifer testing conducted at the site, the upper lean clay deposits exhibit low permeability, do not yield adequate quantities of water to wells, and are considered to be an aquitard. The underlying fine-medium sand with silt is considered to be an unconfined or possibly semi-confined aquifer and is therefore designated as the uppermost aquifer at the LRCP.

4.0 SUMMARY OF GROUNDWATER MONITORING PROGRAM: TYPE I RESIDUAL WASTE LANDFILL AND LANDFILL RUNOFF COLLECTION POND

In accordance with 40 CFR § 257.90(e) of the CCR Rule, annual Groundwater Monitoring and Corrective Action Reports have been prepared for the Clifty Creek Station for CCR program activities conducted in 2017 (AGES 2018a) and 2018 (AGES 2019a). The reports documented the status of the groundwater monitoring and corrective action program for each CCR unit, summarized the key actions completed during 2017 and 2018, described any problems encountered, discussed actions to resolve the problems, and projected key activities for the upcoming year. Applicable details of the reports are presented below in Sections 4.1, 4.2, and 4.3.

4.1 Groundwater Monitoring Network

As detailed in the Monitoring Well Installation Report (AGES 2018b), the CCR groundwater monitoring network for the Type I Landfill and LRCP consists of the following eight (8) monitoring wells:

- CF-15-04 (Background);
- CF-15-05 (Background);
- CF-15-06 (Background);
- CF-15-07 (Downgradient);

- CF-15-08 (Downgradient);
- CF-15-09 (Downgradient);
- WBSP-15-01 (Background); and
- WBSP-15-02 (Background).

The locations of all the wells in the groundwater monitoring network are shown on Figure 4-1. As listed above and shown on Table 4-1, the CCR groundwater monitoring network includes five (5) background and three (3) downgradient monitoring wells, which satisfies the requirements of the CCR Rule. Generalized groundwater flow maps (including the Ohio River) for March and October 2018 are included in Appendix A.

4.2 Groundwater Sampling

In accordance with 40 CFR § 257.94 of the CCR Rule, the first round of Detection Monitoring was conducted in March 2018. Based on the results of the statistical evaluation of the Detection Monitoring data, the Type I Landfill and LRCP entered into Assessment Monitoring in September 2018 and the first round of Assessment Monitoring samples was collected in October 2018.

All groundwater samples were collected in accordance with the Groundwater Monitoring Program Plan (GMPP) (AGES 2018c). The Detection Monitoring samples were analyzed for all Appendix III constituents, and the Assessment Monitoring samples were analyzed for all Appendix III and Appendix IV constituents. All samples were shipped to an analytical laboratory to be analyzed for all of the parameters listed in Appendix III and/or Appendix IV of the CCR Rule.

4.3 Analytical Results

The analytical results for groundwater samples collected in 2018 are summarized in Appendix B. Upon receipt, the March 2018 Detection Monitoring data were statistically evaluated in accordance with 40 CFR § 257.93(f) of the CCR Rule and the Statistical Analysis Plan (StAP) (Stantec Consulting Services, Inc. [Stantec] 2018) for the CCR program. This initial statistical evaluation of the Detection Monitoring data identified potential SSIs for pH and Boron (Appendix III constituents) in three (3) wells (CF-15-07, CF-15-08 and CF-15-09). As discussed in the 2018 Groundwater Monitoring and Corrective Action Report, a faulty pH meter was suspected of causing the SSIs for pH. In accordance with the StAP, the wells were re-sampled for pH and Boron in May 2018. Based on the results of the re-sampling, the SSIs were only confirmed for Boron in wells CF-15-08 and CF-15-09 (Table 4-2).

Upon receipt, the October 2018 Assessment Monitoring results were statistically evaluated in accordance with 40 CFR § 257.93(f) of the CCR Rule and the StAP (Stantec 2018). The initial statistical evaluation identified potential SSIs for Boron (Appendix III constituent) in wells CF-15-08 and CF-15-09. In accordance with the StAP, the wells were re-sampled for those constituents in December 2018. Based on the results of the re-sampling, the SSIs for Boron

(Appendix III) were confirmed at CF-15-08 and CF-15-09 (Table 4-2). As Appendix IV constituents were also detected in all three (3) downgradient wells, IKEC began the process of establishing a GWPS for any detected Appendix IV constituent.

4.4 Alternate Source Demonstration for Type I Landfill

Based on a review of current and historic data, the Type I Landfill was not believed to be the source of Boron in groundwater in the area. An ASD was therefore completed in general accordance with guidelines presented in the *Solid Waste Disposal Facility Criteria Technical Manual* (U.S. EPA 1993). Based on the ASD, it was concluded that the Type I Landfill was not the source of Boron detected in the area. This conclusion was supported by the following evidence:

- "Foundation soils" that extend from beneath the LRCP and the hydraulically placed fly ash southwest to the Ohio River provide a direct hydraulic connection between the historic hydraulically placed fly ash and the CCR groundwater monitoring wells CF-15-08 and CF-15-09.

- Historic data from the Indiana Department of Environmental Management (IDEM) groundwater monitoring program indicate that Boron concentrations similar to those observed in CCR wells CF-15-08 and CF-15-09 were detected in IDEM wells CF-9406 and CF-9407 for 17 years prior to operation of the Type I Landfill, indicating that the Boron is associated with the historic hydraulically placed fly ash.

- Using the previously calculated groundwater flow velocity of 45 feet per year (ft/yr), it is estimated that it would take 120 years for groundwater flowing beneath the Type I Landfill to reach the CCR monitoring wells.

The ASD Report for the March 2018 Detection Monitoring Event (AGES 2019b) was completed in June 2019 and was certified on July 3, 2019. Based on the successful ASD, an ACM was not required at the Type I Landfill. By definition of the CCR Rule, the LRCP is unlined and the historic hydraulically placed fly ash extends beneath the LCRP to the embankment; therefore, an ACM was conducted at the LRCP.

4.5 Groundwater Protection Standards-LRCP

In accordance with 40 CFR § 257.95(h)(1) through 40 CFR § 257.95(h)(3), IKEC established a GWPS for each Appendix IV constituent that was detected in groundwater (Table 4-3). Results for all Appendix IV constituents were less than the applicable GWPSs, except for Molybdenum in CF-15-08 in October 2018 (524 micrograms per liter [ug/L]) and December 2018 (429 ug/L) (Appendix B). Both results exceeded the GWPS for Molybdenum of 100 ug/L. Molybdenum in CF-15-09 in October 2018 (85.9 ug/L) and December 2018 (87.1 ug/L) did not exceed the GWPS. Molybdenum in CF-15-07 in October 2018 (12.8 ug/L) also did not exceed the GWPS.

Based on these results, IKEC proceeded to characterize the nature and extent of the release, completed required notifications, and initiated an ACM in accordance with 40 CFR § 257.95(g). Results of these activities are presented in the following sections of this report.

5.0 CCR SITE CHARACTERIZATION ACTIVITIES

As specified in the CCR Rule in 40 CFR § 257.95(g)(1), further characterization of the nature and extent of the release to groundwater at the LRCP was required. The objectives of the characterization were to:

- Install additional monitoring wells necessary to define the contaminant plume(s);
- Collect data on the nature of material released including specific information on the constituents listed in Appendix IV and at the levels at which they are present in the material released;
- Install at least one (1) additional monitoring well at the facility boundary in the direction of contaminant migration and sample this well in accordance with § 257.95 (d)(1); and
- Sample all wells in accordance with § 257.95 (d)(1) to characterize the nature and extent of the release.

This section details the work conducted in between February and May 2019 to collect additional data to aid in characterization of the release and assessment of corrective measures. To evaluate the extent of Molybdenum impacts, two (2) additional wells (CF-19-14 and CF-19-15) were installed in the uppermost aquifer at the property boundary downgradient from the LRCP (Figure 5-1). To confirm that Molybdenum had not migrated into the deep aquifer, two (2) other wells (CF-19-08D and CF-18-15D) were also installed in the deep aquifer (clayey gravel with sand) (Figure 5-1). All of these wells were developed, hydraulically tested and sampled for analysis of Appendix III and Appendix IV constituents.

Details regarding this work are presented in the following sections of this report.

5.1 Grain Size Analysis and Monitoring Well Design

The CCR Rule requires that unfiltered groundwater samples be submitted for laboratory analysis of Appendix III and IV constituents. According to the preamble to the CCR Rule, the unfiltered sample requirement assumes that groundwater samples with a turbidity of less than 5 nephelometric turbidity units (NTUs) can be obtained from a properly designed monitoring well. The proper design of the sand pack and well screen in each unconsolidated CCR well is therefore critical to obtaining representative samples.

The four (4) new monitoring wells were designed and installed using the same methods and materials used during the installation of the other wells in the CCR groundwater monitoring network and in accordance with the GMPP (AGES 2018c). During installation, representative samples of the aquifer material from both the uppermost and deep aquifers were collected from well borings CF-19-08D and CF-19-15D. These soil samples were submitted to a geotechnical laboratory for grain-size analysis per American Society for Testing and Materials (ASTM) Methods D421 and D422. The results of the grain size analyses were used to confirm that the design of the well screens and filter packs was appropriate for the CCR monitoring program. In accordance with U.S. EPA monitoring well design guidelines (U.S. EPA 1991), the grain size of the filter pack was chosen by multiplying the 70% retention (or 30% passing) size of the formation, as determined by the grain size analysis, by a factor of 3 (for fine uniform formations) to 6 (for coarse, non-uniform formations). Table 5-1 summarizes the results of the grain-size analysis and the 70% retention size for each of the samples collected from each boring. The laboratory reports are included in Appendix C.

Two (2)-inch diameter 0.01" slotted Schedule 40 polyvinyl chloride (PVC) pre-packed screens designed specifically for sampling metals in groundwater were selected for use in the wells at the LRCP to reduce turbidity. The pre-packed well screens were constructed using an inner filter pack consisting of 0.40 millimeter (mm) clean quartz filter sand between two layers of food-grade plastic mesh to reduce sample turbidity by filtering out smaller particles than is possible with standard filter packed wells and prepack screens. No metal components were used in the construction of the pre-packed well screens, thus eliminating potential interference with metals analysis.

5.2 Monitoring Well Installation, Development, Sampling, and Testing

5.2.1 Monitoring Well Installation

From March 4 through 21, 2019, a total of four (4) additional monitoring wells were installed at the LRCP using hollow stem auger drilling methods. During drilling, the drill bit was simultaneously pushed down and rotated. Continuous split-spoon samples were logged by the AGES geologist. The augers were used to advance each boring to the desired depth and were kept in place to keep the borehole open during well installation. The augers were then removed as the well installation progressed.

Once each borehole was advanced to the desired depth, a 5-foot or 10-foot pre-packed well screen was set into the borehole. An outer filter pack consisting of 0.40 mm clean quartz sand was installed directly around the pre-packed well screen. The sand was placed as the augers were pulled back in one (1)- to two (2)- foot increments to reduce caving effects and ensure proper placement of the filter pack. The filter pack extended one (1)-foot above the top of the screen.

A two (2)-foot thick annular bentonite seal was installed above the filter pack in each well. Once in place, the bentonite seal was allowed to hydrate before the remainder of the annular space around each monitoring well was backfilled using a grout consisting of Portland cement and bentonite. Each monitoring well was completed with an above-ground protective steel casing and a locking well cap. Following installation, each monitoring well was surveyed for elevation and location by IKEC personnel.

Well construction details for the four (4) new wells installed at the LRCP are presented in Table 5-2. All well boring and construction logs are included in Appendix D.

5.2.2 Monitoring Well Development

Well development was initiated at least 48 hours after installation of each of the monitoring wells. Development consisted of alternating surging and pumping with a submersible pump. During development of the monitoring wells, field parameters including temperature, specific conductance, pH, and turbidity were recorded at regular intervals. Development continued until each parameter stabilized and turbidity was less than 5 NTUs. Well development data for each well is summarized on Table 5-3.

5.2.3 Groundwater Sampling

On March 26 and March 28, 2019, the four (4) new monitoring wells were sampled in accordance with the Clifty Creek GMPP (AGES 2018c) for all Appendix III and Appendix IV constituents. The monitoring wells were purged using a pump to remove stagnant water in the casing and to ensure that a representative groundwater sample was collected.

Samples were collected in laboratory provided, pre-preserved (if necessary) bottleware. All bottles were labeled with the unique sample number, time and date of sample collection, and the identity of the sampling fraction. Field parameters were measured and recorded on purging forms at the time of sample collection.

Following sample collection, the samples were packed in ice in coolers insulated to four degrees centigrade ($4^{o}C$) and shipped to the TestAmerica analytical laboratory located in Canton, Ohio.

5.2.4 Aquifer Testing

In April 2019, slug tests were conducted on all of the new wells (CF-19-08D, CF-19-14, CF-19-15 and CF-19-15D) to obtain data to calculate the saturated hydraulic conductivity (K) for the shallow and deep aquifers beneath the LRCP. Both rising and falling head slug tests were performed on each well. The falling head tests were performed by lowering a pre-fabricated solid slug with a known volume, into the water column of the well and recording the drop in head over time. The rising head tests were performed by removing the solid slug and recording the rise in head over time. The change of head over time was recorded using a data logger and pressure transducer. Dedicated rope was used for each well and the slug was decontaminated using the procedures specified in the GMPP for the Clifty Creek Station (AGES 2018c).

The slug test data were evaluated using AQTESOLV, a commercially available software package. Data from each monitoring well were analyzed using both the Bouwer-Rice and Hvorslev slug test solutions (with automatic curve matching) which are straight-line analytical techniques commonly used to analyze rising and falling head slug test data. The AQTESOLV data for each well are presented in Appendix E.

5.3 Results of Site Characterization

5.3.1 Site Geology Updates

Based on the results of the site characterization, an update to the understanding of the geology at the unit is not necessary. The boring logs maintained during monitoring well installation confirmed that a fine-medium sand is the uppermost aquifer and confirmed the presence of a clay layer at a depth of 35 to 40 feet below ground surface (bgs) that separates the uppermost aquifer from the deep aquifer. The unconsolidated deposits overlay limestone bedrock of the Dillsboro Formation at depths ranging from 15 to 90 feet bgs.

5.3.2 Groundwater Flow

A complete round of groundwater level data was collected in March 2019 from the wells south of the LRCP (Table 5-4). A groundwater flow map generated using these data indicates that groundwater in the uppermost aquifer beneath the LRCP flows to the south toward the Ohio River (Figure 5-2). Groundwater in the deep aquifer also flows from the north (CF-19-08; groundwater elevation of 442.16 ft msl) to south (CF-19-15D; groundwater elevation of 428.77 ft msl) toward the Ohio River. Historic groundwater elevation data indicates that groundwater flow beneath the LRCP is affected by the flow and water level in the Ohio River and evidence of several flow reversals have been observed in the historic data (AGES 2018a).

5.3.3 Slug Testing

Slug test results from testing completed in May 2016 and April 2019 are summarized on Table 5-5. The revised mean K for the uppermost aquifer beneath the LRCP is 8.23×10^{-4} feet per second (ft/sec). The mean K for the deep aquifer is 1.31×10^{-5} ft/sec. Published literature indicates that these are reasonable K values for these type of unconsolidated deposits (Fetter 1980).

5.3.4 Groundwater Flow Velocity

Using water level data collected in March 2019 and hydraulic conductivity data from the recent slug tests (Tables 5-4 and 5-5), the average groundwater velocity for the uppermost and deep aquifers beneath the LRCP was estimated. The calculated average groundwater velocity for the shallow aquifer is 7.43 feet per day (ft/day) (Table 5-6). With this flow velocity and a distance between wells CF-15-08 and CF-19-15 (at the property boundary) of approximately 523 feet, the travel time for groundwater to flow between CF-15-08 and CF-19-15 is approximately 70 days.

The calculated average groundwater velocity for the deep aquifer is 0.1446 ft/day (Table 5-6). With this flow velocity and a distance between wells CF-15-08D and CF-19-15D (at the property boundary) of approximately 523 feet, the travel time for groundwater to flow between CF-15-08 and CF-19-15 is approximately 3,617 days.

5.3.5 Groundwater Sampling Results

Analytical results for Appendix III and Appendix IV constituents in the four (4) new wells are presented on Table 5-7.

In the uppermost aquifer, Molybdenum concentrations south of the LRCP ranged from 4.9 ug/L in CF-15-07 to 380 ug/L in CF-15-08 (Figure 5-3). Molybdenum concentrations in the two (2) new shallow wells at the property boundary were 1.1 ug/L in CF-19-15 and 12 ug/L in CF-19-14. Based on these results, Molybdenum concentrations in the uppermost aquifer exceeding the GWPS of 100 ug/L are confined to the site and are not reaching the Ohio River. However, to address Molybdenum concentrations in the uppermost aquifer an ACM is required.

In the deep aquifer, Molybdenum concentrations were 31 ug/L in CF-19-08D and 49 ug/L in CF-19-15D (Figure 5-3). Based on these results, Molybdenum impacts are confined to the uppermost aquifer as these concentrations are less than the GWPS of 100 ug/L. Further evaluation of Molybdenum in the deep aquifer is therefore not required.

6.0 ASSESSMENT OF CORRECTIVE MEASURES

Groundwater monitoring of the uppermost aquifer at the LRCP has identified Molybdenum (an Appendix IV constituent) at concentrations that exceed the GWPS defined under 40 CFR § 257.95(h); therefore, an ACM is necessary. The ACM will require identification and evaluation of technologies and methods that may be used as elements of remedial actions to meet the requirements of the CCR Rule. These elements include potential source control methods and various groundwater remedial technologies that may be applicable to the LRCP. Additional remedial technologies may also be evaluated at a later date, if determined to be applicable and appropriate.

Presented below is a discussion of the objectives of the ACM, the potential source control measures, a list of remedial technologies, a summary of the assessment process, and the detailed ACM evaluation.

6.1 Objectives of Remedial Technology Evaluation

Per 40 CFR § 257.96(a), the objectives of the corrective measures evaluated in this ACM Report are "to prevent further releases, to remediate any releases, and to restore affected area to original conditions." As required in 40 CFR § 257.97(b), corrective measures, at minimum, must:

(1) Be protective of human health and the environment;

(2) Attain the groundwater protection standard as specified pursuant to § 257.95(h);

(3) Control the source(s) of releases so as to reduce or eliminate, to the maximum extent feasible, further releases of constituents in Appendix IV to this part into the environment;

(4) Remove from the environment as much of the contaminated material that was released from the CCR unit as is feasible, taking into account factors such as avoiding inappropriate disturbance of sensitive ecosystems;

(5) Comply with standards for management of wastes as specified in § 257.98(d).

6.2 Potential Source Control Measures

The objective of source control measures is to prevent further releases from the source (i.e., the LRCP). According to 40 CFR § 257:

"Remedies must control the source of the contamination to reduce or eliminate further releases by identifying and locating the cause of the release. Source control measures may include the following: Modifying the operational procedures (e.g., banning waste disposal); undertaking more extensive and effective maintenance activities (e.g., excavate waste to repair a liner failure); or, in extreme cases, excavation of deposited wastes for treatment and/ or offsite disposal. Construction and operation requirements also should be evaluated."

The detailed evaluation of source control measures at the LRCP is provided in Table 6-1. Three (3) technologies are included in this evaluation:

- Dewatering of Pond Water;
- Engineered Cover System; and
- Excavation of Ash.

Per state and federal regulatory requirements and timelines, IKEC tentatively plans to close the LRCP. The method and timing of closure of the unit will depend on receipt of approval from the IDEM. Source control through closure will likely initially include the cessation of ongoing wastewater and storm water discharge into the LRCP, a combination of passive and active decanting of ponded water within the unit, and interstitial dewatering of ash pore-water within the unit.

Groundwater quality near the LRCP is anticipated to significantly improve over time as a result of the above-referenced closure activities. Terminating wastewater and storm water discharge to the LRCP, coupled with decanting of ponded water, will significantly decrease the hydraulic head in the LRCP and thereby significantly reduce infiltration of water from the unit to the underlying groundwater. Dewatering of the ash will also reduce the contact-time for Molybdenum with the ash pore-water, which should reduce the mobility of the Molybdenum. Groundwater monitoring over time is necessary to fully evaluate the positive impact that closure of the LRCP will have on groundwater quality.

6.3 Potential Remedial Technologies

The focus of corrective measures for the LRCP is to address Molybdenum in groundwater that exceeded the GWPS. To accomplish this, the following three (3) types of technologies will be presented in Sections 6.3.1 through 6.3.3:

- In-Situ Groundwater Remedial Technologies;
- Ex-Situ Groundwater Remedial Technologies; and
- Treatment of Extracted Groundwater.

As described in Section 6.2, groundwater quality near the LRCP is anticipated to significantly improve over time as a result of planned closure activities. Therefore, a flexible and adaptive approach to groundwater remediation that begins with post-closure groundwater monitoring at the unit is planned. During the post-closure monitoring period, the positive impacts of closure and the effects of natural attenuation on groundwater quality will be fully evaluated. The need for more active remedial measures (as discussed below) will be determined after sufficient post-closure groundwater quality data has been collected and evaluated. The final selection of a remedy will be made based on the results of the post-closure groundwater monitoring program.

The detailed ACM evaluation is provided in Table 6-2 and summarized below in Section 6.4. Additional remedial technologies may also be evaluated if determined to be applicable and appropriate.

6.3.1 In-Situ Groundwater Remedial Technologies

In-situ groundwater remediation approach involves treating the groundwater where it is presently situated, rather than removing and transferring it elsewhere for treatment and disposal. Long-term groundwater monitoring would be required to evaluate the effectiveness of any of these technologies. In-situ groundwater remediation technologies are discussed below.

6.3.1.1 Monitored Natural Attenuation (MNA)

MNA is a strategy and set of procedures used to demonstrate that physical, chemical and/or biological processes in an aquifer will reduce concentrations of constituents to levels below applicable standards. These processes attenuate the concentrations of inorganics in groundwater by physical and chemical means (e.g., dispersion, dilution, sorption, and/or precipitation). Dilution from recharge to shallow groundwater, mineral precipitation, and constituent adsorption will occur over time, which will further reduce constituent concentrations through attenuation. Regular monitoring of select groundwater monitoring wells is conducted to ensure constituent concentrations in groundwater are attenuating over time.

6.3.1.2 Groundwater Migration Barriers

Low permeability barriers can be installed below the ground surface to prevent groundwater flow from reaching locations that pose a threat to receptors. Barriers can be installed with continuous trenching techniques using bentonite or other slurries as a barrier material to prevent migration of groundwater. Barriers of cement/concrete and sheet piling can also be used.

Barriers are most effective at preventing flow to relatively small areas or to protect specific receptors. Protecting larger areas is possible if the constituent of concern is not highly soluble and cannot follow a diverted groundwater flow pattern. The barrier will change the groundwater flow conditions, and at some point the increased head (pressure) will cause a change in flow patterns. This will generally be around the flanks or beneath the barrier. To ensure that groundwater will not flow beneath the barrier, it must be sealed at an underlying impermeable layer such as a clay layer.

Groundwater migration barriers are often used in conjunction with groundwater extraction systems. The barriers are used to restrict flow to allow extraction systems upgradient of the barrier to collect groundwater. However, the challenges discussed above for creating a competent seal with any underlying unit may still apply.

6.3.1.3 Permeable Reactive Barriers (PRBs)

Permeable reactive barriers (PRBs) can be an effective in-situ groundwater treatment technology. General design involves excavation of a narrow trench perpendicular to groundwater flow similar to migration barriers and then backfilling the trench with a reactive material that either removes or transforms the constituents as the groundwater passes through the PRB. Unlike simple barriers, the PRB can be designed to include impermeable sections to funnel the flow through a more narrow and permeable reactive zone. The ability to maintain adequate and reactive reagent concentrations at depth over an extended period of time is a significant operational and performance assurance challenge. As with other in-situ approaches, reconstruction or regeneration may be needed on a periodic basis.

6.3.1.4 In-Situ Chemical Stabilization

The placement of chemical reactants to immobilize dissolved phase constituents through precipitation or sorption can be an effective approach to reducing downgradient migration. Reagents such as ferrous sulfate, calcium polysulfide, zero-valent iron, organo-phosphorous mixtures, and sodium dithionate have been evaluated as potentially effective for coal ash related constituents.

Two (2) issues that must be considered with this technology are permanence of the reaction product insolubility and the ability to inject the reactants sufficiently to ensure adequate contact with the constituents. Most stabilization reactions can be reversible depending on environmental conditions such as pH and oxidation state. Given the long periods of time for which the reaction products must remain insoluble, it may be difficult to predict future conditions sufficiently to ensure permanence of this technology. Recurring treatment, based on routine testing, may be an option. Contact between reagents and the constituents must also be evaluated. This technology may need to be considered more as a source reduction technology than a capture or barrier technology, as the reactants may not be viable over an extended period of time.

6.3.2 Ex-Situ Groundwater Remedial Technologies

Ex-situ remedial technologies require groundwater extraction to remove constituent mass from the groundwater and can provide hydraulic control to reduce or prevent groundwater constituent migration. Groundwater can be removed from the aquifer through the use of conventional vertical extraction wells, horizontal wells, collection trenches and associated pumping systems. The type of well or trench system selected is based upon site-specific conditions. Long-term groundwater monitoring would be required to evaluate the effectiveness of any of these technologies. Ex-situ groundwater remediation technologies are discussed below.

6.3.2.1 Conventional Vertical Well System

Conventional vertical wells can usually be used in most cases unless accessibility is an issue. Well spacing and depths depend upon the aquifer characteristics. If flow production from the aquifer is extremely limited, conventional wells may not be feasible due to the extremely close spacing that would be required. Vertical wells may be used at any depth and can be screened in unconsolidated soils or completed as open-hole borings in bedrock.

6.3.2.2 Horizontal Well Systems

The use of horizontal recovery wells has increased due to development of more efficient horizontal drilling techniques. These systems can cover a significant horizontal cross-section and may be much more efficient than conventional vertical wells. They are not well suited to aquifers with wide variation in water levels, as the horizontal well may end up being dry.

6.3.2.3 Trenching Systems

Horizontal collection trenches function similarly to horizontal wells but are installed with excavation techniques. They can be more effective at shallow depths and with higher flow regimes. However, they may not be practical for deeper installations.

6.3.3 Treatment of Extracted Groundwater

Several technologies exist for treatment of extracted groundwater to remove or immobilize constituents ex-situ. The following technologies would be considered if treatment of extracted groundwater became necessary prior to a permitted discharge. As presented in the following sections, there are three (3) primary treatment technologies that are applicable to Molybdenum:

- Filtration;
- Ion Exchange; and
- Other Adsorbents.

6.3.3.1 Filtration Technologies

There are a number of permeable membrane technologies that can be used to treat impacted groundwater for metals and other constituents. The most common is reverse osmosis, although microfiltration, ultrafiltration, and nanofiltration are also used. All of these technologies use pressure to force impacted water through a permeable membrane, which filters out the target constituents. The differences in the technologies are based on the filtration size and the corresponding pressure needed to operate the system. These membrane technologies can capture a number of target compounds simultaneously and can achieve low effluent concentrations, but they are also very sensitive to fouling and often require a pretreatment step. Membrane technologies can result in a relatively high volume reject effluent, which may require additional treatment prior to disposal.

6.3.3.2 Exchange Technologies

Ion exchange is a well proven technology for removing metals from groundwater. With some constituents, ion exchange can achieve very low effluent concentrations. Ion exchange is a physical process in which ions held electrostatically on the surface of a solid are exchanged for target ions of similar charge in a solution. The medium used for ion exchange is typically a resin made from synthetic organic materials, inorganic materials, or natural polymeric materials that contain ionic functional groups to which exchangeable ions are attached. The resin must be regenerated routinely, which involves treatment of the resin with a concentrated solution, often containing sodium or hydrogen ions (acid). There must be a feasible method to dispose of the regeneration effluent for this technology. Pretreatment may be required, based on site specific conditions.

6.3.3.3 Adsorption Technologies

Groundwater containing dissolved constituents can be treated with adsorption media to reduce their concentration. However, the column must be regenerated or disposed of and replaced with new media on a routine basis. Common adsorbent media include activated alumina, copper-zinc granules, granular ferric hydroxide, ferric oxide-coated sand, greensand, zeolite, and other proprietary materials. This technology may also generate a significant regeneration waste stream.

6.4 Evaluation to Meet Requirements in 40 CFR § 257.96(c)

For this evaluation, each of the potential remedial technologies identified above will be screened against evaluation criteria requirements in 40 CFR § 257.96(c) listed below:

The assessment under paragraph (a) of this section must include an analysis of the effectiveness of potential corrective measures in meeting all of the requirements and objectives of the remedy as described under § 257.97 addressing at least the following:

(1) The performance, reliability, ease of implementation, and potential impacts of appropriate potential remedies, including safety impacts, cross-media impacts, and control of exposure to any residual contamination;

(2) The time required to begin and complete the remedy;

(3) The institutional requirements, such as state or local permit requirements or other environmental or public health requirements that may substantially affect implementation of the remedy(s).

The ACM evaluation is provided in Table 6-2 and detailed below.

6.4.1 <u>Performance</u>

This criterion includes the ability of the technology to effectively achieve the specified goal of corrective measures to prevent further releases, to remediate any releases, and to restore the affected area to original conditions.

6.4.1.1 In-Situ Groundwater Remedial Technologies

MNA is a proven technology that can be implemented to reduce constituent concentrations over time through natural processes of geochemical and physical attenuation. Typical attenuation mechanisms that could affect Molybdenum would include adsorption, precipitation, and dispersion. Molybdenum is highly sensitive to changes in oxidation-reduction conditions in groundwater. It is more mobile at higher Oxidation Reduction Potential (ORP) values; it is weakly adsorbed with minimal mineral formation (precipitation) at pH values in the range of 6.5 to 7.5 (Smedley and Kinniburgh 2017). At the LRCP, ORP values varied significantly in 2018 with ranges of -50 millivolts (mV) to 34.7 mV at CF-15-07; -47.7 mV to 335 mV at CF-15-08; and -50.4 mV to 325.1 mV at CF-15-09 (AGES 2019a). The pH values at the LRCP were more consistent ranging from 7.05 to 7.61 Standard Units (SU) at all three (3) wells over the course of 2018. The wide range of ORP values are likely related to flood events when the groundwater flow direction reverses and water from the Ohio River recharges groundwater at the site. Within this range of values, the mobility of Molybdenum would vary (due to ORP variations) and there would be limited adsorption and precipitation (due to the pH range).

Dispersion, the mixing and spreading of constituents due to microscopic variations in velocity within and between interstitial voids in the aquifer, and dilution would reduce Molybdenum concentrations but would not destroy the Molybdenum. Given groundwater flow conditions, with periodic flood events and flow reversals, dispersion and dilution of Molybdenum would likely be a major factor in natural attenuation.

At the LRCP, the existing well network would be used to monitor constituent trends over time. Given that Molybdenum concentrations are less than the GWPS at the property boundary, a long-term timeframe would likely be acceptable.

Although migration barriers, PRBs, and in-situ chemical stabilization are proven technologies, conditions at the LRCP would limit the performance of each of these approaches. To be effective, a migration barrier would need to be tied into a lower competent unit at the LRCP; either the lean clay layer at approximately 40 feet bgs or bedrock at 80 to 90 feet bgs. Given that the LRCP is located within an impermeable bedrock valley, these conditions would be conducive to this approach. Under these conditions, any altered flow paths due to the presence of the barrier could likely be managed. Note that periodic flooding of the area by the Ohio River would also impact the performance of these technologies.

A groundwater extraction system may also be coupled with this technology to increase its long-term effectiveness. Similar to the migration barrier, a PRB could also be installed at the LRCP. However, maintaining adequate reagent concentrations at depth over time is a significant issue. In addition, the effectiveness of this approach to treat Molybdenum is not well tested or established.

Given site conditions, in-situ chemical stabilization reagents could be injected into the uppermost aquifer and distributed to where impacts occur. It would be critical to fully evaluate future groundwater conditions (i.e., pH, ORP, etc.) to maintain this approach. The effectiveness of this approach to treat Molybdenum is not well tested or established.

6.4.1.2 Ex-Situ Groundwater Remedial Technologies

Groundwater extraction is a proven technology that has been successfully implemented for decades at many sites. Conventional vertical wells are the most often used approach; although the use of horizontal wells has been increasing. At the LRCP, a series of vertical recovery wells can likely be installed and operated to address impacted groundwater. Horizontal wells operate in a similar manner to vertical wells but are less effective in areas with significant water level fluctuations, like the LRCP. The performance of both types of wells would be significantly impacted by the Iron content of groundwater, which can lead to clogging. Significant levels of operation and maintenance would likely be necessary.

Trenching systems are often used when groundwater impacts are encountered in a shallow unit. The depth to groundwater at the LRCP is 15 to 20 feet bgs and the depth to the lean clay layer is 40 feet bgs. Although these depths are not ideal for a trench, they do not preclude the use of a trench at the LRCP.

Note that periodic flooding of the area by the Ohio River would also impact the performance of these ex-situ technologies.

6.4.1.3 Treatment of Extracted Groundwater

Groundwater treatment is required as a supplemental technology to be used in conjunction with groundwater extraction. The need for treatment depends on permit requirements for discharge of the treated water via a National Pollution Discharge Elimination System (NPDES) permit. The concentrations of Molybdenum would need to be reduced to less than the required permit limits. Treatment for other constituents may also be required based on permit requirements.

Treatment of extracted groundwater can be performed, although Molybdenum is one of the more difficult constituents to remove from water. Molybdenum removal can be accomplished in both continuous and sequential batch processes. A typical batch operation would consist of chemical storage and dosing modules; a primary reactor and pretreatment holding tank; a solids dewatering device (if needed); and miscellaneous temperature and pH controls. Prior to design, bench scale testing should be conducted to fully evaluate site-specific conditions. Pilot testing would also likely be performed, if favorable results are obtained from the bench scale testing, prior to design and construction of a full-scale treatment system.

6.4.2 Reliability

This criterion includes the degree of certainty that the technology will consistently work toward and achieve the specified goal of corrective measures over time.

6.4.2.1 In-Situ Groundwater Remedial Technologies

As the process of MNA is based on natural processes, this approach would be considered to be reliable. However, as groundwater geochemistry can vary over time, routine monitoring is required to evaluate conditions and ensure the ongoing effectiveness of the MNA process. Geochemical changes in groundwater could significantly impact the effectiveness of MNA, which could lead to the need to implement other remedial measures at the LRCP.

Migration barriers and PRBs are typically reliable technologies; the primary issue being the potential for altered groundwater flow directions and further migration of constituents. In addition, maintaining adequate and reactive reagent concentrations at depth over an extended period of time in a PRB can also be a significant operational and maintenance issue.

For in-situ chemical stabilization, reagents must be injected uniformly and consistently to adequately distribute them into the aquifer. Lack of a uniform and consistent approach could lead to reliability issues. Finally, changes in the geochemistry of the aquifer can lead to the need for adjustments in reagent type, concentrations and injection approach.

6.4.2.2 Ex-Situ Groundwater Remedial Technologies

Groundwater extraction solutions are generally considered reliable at controlling and removing constituents from the subsurface. At the LRCP, conventional vertical wells would be the more reliable approach, as the large water level fluctuations at the unit would significantly impact the reliability of horizontal wells. There can be significant operation and maintenance issues associated with both conventional vertical or horizontal wells but these issues are well understood and can be readily addressed. Once in the place, trenching systems would also be reliable at the LRCP although long term Operations and Maintenance (O&M) would be required.

6.4.2.3 Treatment of Extracted Groundwater

Treatment of Molybdenum in extracted groundwater would be reliable as long as the bench-scale/pilot-test process outlined above is properly implemented.

6.4.3 Ease of Implementation

This criterion includes the ease with which the technologies can be implemented at the LRCP.

6.4.3.1 In-Situ Groundwater Remedial Technologies

MNA is among the easiest of corrective measures to implement at a site. A sufficient number of monitoring wells already exist at the LRCP, which could be used to monitor the effectiveness of MNA.

Due to the significant amount of time, effort, and disturbance required for implementation at the LRCP, migration barriers, in-situ chemical stabilization and PRBs implementation would be difficult. Difficulties in construction would be related to the depth of installation and the need to install a barrier into the lean clay layer at the site at a depth of 40-feet bgs. Once constructed, the barrier technology would be passive and would operate immediately. The PRB would likely require periodic recharging with appropriate reagents. In-situ chemical stabilization may require less time and effort than with a migration barrier or PRB.

6.4.3.2 Ex-Situ Technologies for Groundwater Extraction

Implementation of both conventional vertical and horizontal wells at the LCRP would require drilling and limited field construction; however, the conventional vertical wells would be the more easily implemented. The orientation of the horizontal wells could present potential installation issues. Trenching systems would require significant construction and would be difficult to implement at the LRCP.

6.4.3.3 Treatment of Extracted Groundwater

Treatment of Molybdenum in extracted groundwater can be implemented but would require the bench-scale/pilot-test process outlined above.

6.4.4 <u>Potential Safety Impacts</u>

This criterion includes potential safety impacts that may result from implementation and use of the technology at the LRCP.

6.4.4.1 In-Situ Groundwater Remedial Technologies

Potential safety impacts associated with MNA are very minimal; especially as no additional well installation is required. Minimal safety concerns are therefore associated with the ongoing groundwater monitoring program.

Migration barriers and PRBs require a significant construction effort and use of construction equipment, which would entail a relatively high risk of potential safety impacts. However, neither technology would have any potential significant safety impacts following construction. Potential safety concerns related to in-situ chemical stabilization are moderate. The potential for incidents during injection well construction or unintended worker contact with the chemicals used for treatment would be the primary safety concerns with this technology.

6.4.4.2 Ex-Situ Groundwater Remedial Technologies

Groundwater extraction through use of wells (conventional vertical or horizontal) would involve drilling, construction, and installation of extraction wells, pumps, and associated control wiring and piping. Potential safety concerns exist with the activities associated with installation of these wells, as well as the ongoing operations and maintenance of the system, including inspection, maintenance, or replacement of the various system components.

Trenching systems would require use of significant construction equipment and present worker safety concerns, especially with the depth of the trench. Ongoing operation of the system would present minimal safety concerns.

6.4.4.3 Treatment of Extracted Groundwater

Treatment of extracted Molybdenum in groundwater would have minimal safety concerns.

6.4.5 Potential Cross-Media Impacts

This criterion includes the ability to control cross-media impacts during implementation and use of the technology at the LRCP.

6.4.5.1 In-Situ Groundwater Remedial Technologies

MNA poses no significant cross-media impact potential. Migration barriers and PRBs pose minimal risk of cross-media impacts, as they primarily involve an intended modification in groundwater flow. For a barrier technology, there could be some risk with the migration of impacted groundwater to other areas of the site; this concern is minimal. In the case of PRBs, constituents are removed from the groundwater through use of reagents; this includes minimal potential for cross-media impacts.

6.4.5.2 Ex-Situ Groundwater Remedial Technologies

Well and trench systems pose a moderate risk of cross-media impacts.

6.4.5.3 Treatment of Extracted Groundwater

Treatment of extracted groundwater would pose minimal risk of cross-media impacts.

6.4.6 Potential Impacts from Control of Exposure to Residual Constituents

This criterion includes the ability to control exposure of humans and the environment to residual constituents through implementation and use of the technology at the LRCP.

6.4.6.1 In-Situ Groundwater Remedial Technologies

MNA poses no significant potential for human or environmental exposure to impacted groundwater. Overall, in-situ technologies involve placement or injection of a structure or reagent to treat impacted groundwater in-place. Consequently, there is no increased risk of exposure of humans and the environment to residual contamination.

6.4.6.2 Ex-Situ Groundwater Remedial Technologies

Groundwater extraction involves bringing impacted groundwater from the subsurface to the surface for potential treatment and discharge. This would slightly increase the potential for exposure of humans or the environment to impacted groundwater. The groundwater would be conveyed through an engineered system designed to prevent the release of water into the environment and to limit the potential for human or environmental exposure to the impacted groundwater. The potential for exposure to residual contamination associated with this technology is therefore unlikely.

6.4.6.3 Treatment of Extracted Groundwater

Treatment of extracted groundwater would pose minimal risk of exposure to residual contamination.

6.4.7 Time Required to Begin Remedy

This criterion includes the time necessary for planning, pilot testing, design, permitting, procurement, installation, and startup of this technology at the LRCP. Timeframes presented below and in Table 6-2 reflect the time required to implement the remedy after closure of the unit.

6.4.7.1 In-Situ Groundwater Remedial Technologies

A MNA program could be implemented at the LRCP within three (3) months, as a sufficient monitoring well network already exists at the site and a monitoring program is already established. This potential remedy would require the least amount of time to implement of the technologies considered.

Migration barriers, in-situ chemical stabilization, and PRBs could take a significant amount of time to design and install. Either technology would also involve a significant amount of regulatory permitting. The design and implementation time could take 1 to 1.5 years.

6.4.7.2 Ex-Situ Groundwater Remedial Technologies

Design and installation of groundwater extraction systems could be completed in six (6) months to one (1) year. This could vary depending on potential groundwater modeling efforts and regulatory approval and permitting.

6.4.7.3 Treatment of Extracted Groundwater

Design and installation of the system, including bench-scale and pilot testing, could be completed in six (6) months to one (1) year. This would depend on the regulatory approval and permitting process.

6.4.8 Time Required to Complete Remedy

This criterion includes the estimated time necessary to achieve the stated goals of corrective measures to prevent further releases from the LRCP, to remediate any releases, and to restore the affected area to original conditions.

6.4.8.1 In-Situ Groundwater Remedial Technologies

As MNA does not require additional physical or chemical remedial treatment, the timeframe is the longest period to reach remedial goals. A groundwater model would be useful to more accurately predict the anticipated time required to complete the remediation.

A significant amount of time is expected to be required to meet remedial goals with migration barriers and PRB. However, as groundwater modeling has not been performed for the site, an accurate estimate cannot be developed at this time. If in-situ chemical stabilization option can effectively treat Molybdenum at the unit boundary, this approach has the potential to treat groundwater more quickly than a barrier or PRB.

6.4.8.2 Ex-Situ Groundwater Remedial Technologies

A significant amount of time is expected to be required to meet remedial goals with ex-situ technologies. However, as groundwater modeling has not been performed for the site, an accurate estimate cannot be developed at this time.

6.4.8.3 Treatment of Extracted Groundwater

The time required to meet remedial goals depends on the type of groundwater extraction system implemented. The time required for treatment of extracted groundwater is insignificant.

6.4.9 State, Local, or Other Environmental Permit Requirements That May Impact Implementation

This criterion includes anticipation of any state or local permit requirements or other environmental or public health requirements that may substantially affect implementation of the technology at the LRCP.

6.4.9.1 In-Situ Groundwater Remedial Technologies

A MNA program would likely require coordination with IDEM but likely not formal approval. Therefore, it could be implemented in as little as (3) months, as a sufficient monitoring well network already exists at the site.

Migration barriers, in-situ chemical stabilization, and PRBs would require installation of barrier walls and associated components in the aquifer and/or chemical injections, which may require permitting through IDEM. This would require an anticipated minimum of 1 to 1.5 years of review and approval.

6.4.9.2 Ex-Situ Groundwater Remedial Technologies

A groundwater extraction system would require the installation of new wells and a treatment system at the LRCP, which may require permitting through IDEM. This would require an anticipated minimum of 1 to 1.5 years of review and approval.

6.4.9.3 Treatment of Extracted Groundwater

The selection of a treatment system may require permitting through IDEM, especially if a NPDES permit is required. This would require an anticipated minimum of 1 to 1.5 years of review and approval.

6.5 Conclusions

For this evaluation, several in-situ and ex-situ remedial technologies to address Molybdenum in groundwater at the LRCP were screened against evaluation criteria requirements in 40 CFR § 257.96(c). As presented in Table 6-2, during the screening, the technologies were ranked as High, Medium or Low using professional judgement and past experience. Based on these rankings, the two (2) technologies that appear to be most likely for selection as a remedy were:

- MNA; and
- Conventional Vertical Well System (Groundwater Extraction) (Ex-Situ).

Groundwater treatment would be required as a supplemental technology in conjunction with a Conventional Vertical Well System. The selection of a treatment technology would be based on conditions at the time of selection of a final remedy.

The technologies that appear to be less likely for selection as a remedy were:

- Groundwater Migration Barriers (In-Situ);
- PRB (In-Situ);
- In-Situ Chemical Stabilization (In-Situ);
- Horizontal Well Systems (Ex-Situ); and
- Trenching Systems (Ex-Situ).

As groundwater quality near the LRCP is anticipated to significantly improve over time as a result of planned closure activities, a flexible and adaptive approach to groundwater remediation that begins with post-closure groundwater monitoring at the unit is planned. During the post-closure monitoring period, the positive impacts of closure and the effects of natural attenuation on groundwater quality will be fully evaluated. The need for more active remedial measures will be determined after sufficient post-closure groundwater quality data has been collected and evaluated. The final selection of a remedy will be made based on the results of post-closure groundwater monitoring program.

Additional remedial technologies may also be evaluated at a later date if determined to be applicable and appropriate.

7.0 SELECTION OF REMEDY PROCESS

The remedy selection begins following completion of the ACM Report. Per 40 CFR § 257.97(a):

Based on the results of the corrective measures assessment conducted under § 257.96, the owner or operator must, as soon as feasible, select a remedy that, at a minimum, meets the standards listed in paragraph (b) of this section. This requirement applies to, not in place of, any applicable standards under the Occupational Safety and Health Act. The owner or operator must prepare a semiannual report describing the progress in selecting and designing the remedy. Upon selection of a remedy, the owner or operator must prepare a final report describing the selected remedy and how it meets the standards specified in paragraph (b) of this section. The owner or operator must obtain a certification from a qualified professional engineer that the remedy selected meets the *requirements of this section. The report has been completed when it is placed in the operating record as required by § 257.105(h)(12).*

This ACM Report provides a high-level assessment of groundwater remedial technologies that could potentially address Molybdenum concentrations in groundwater that exceed the GWPS at the LRCP. With the submittal of this report, IKEC will begin the remedy selection process and ultimately select a remedy. The remedy selection process and selected remedy will satisfy standards listed in 40 CFR § 257.97(b) with consideration to evaluation factors listed in 40 CFR § 257.97(c). The progress toward selecting a remedy will be documented in semiannual reports.

7.1 Data Gaps

Based on a review of data to date, the following recommendations for additional data collection/evaluation have been identified:

- The development of a three-dimensional (3-D) groundwater model using Modflow or another commercially available software would be useful in supporting the evaluation of various potential remedial techniques at the LRCP.

- As previously discussed, groundwater quality near the LRCP is anticipated to significantly improve over time as a result of planned closure activities and natural attenuation. Ongoing sampling of monitoring wells prior to and after closure of the LRCP should continue to evaluate whether Molybdenum concentrations in groundwater are increasing, decreasing or are asymptotic. This data will be useful in developing time-series evaluations that will support potential groundwater modeling efforts and the final selection of a remedy for the LRCP.

- Additional hydraulic testing near the LRCP would provide more accurate data regarding the hydraulic conductivity and storage coefficient of the uppermost aquifer. This data will be useful in supporting the potential groundwater modeling effort.

- Given the dynamic nature of groundwater flow at the LRCP, additional depth-to-groundwater data from wells in the area would be useful to support the potential groundwater modeling effort. This data can be most efficiently collected by installing downhole transducers in select wells near the LRCP.

7.2 Selection of Remedy

As noted above, IKEC will begin the process of selecting a remedy following submittal of this ACM Report. Per 40 CFR § 257.97, the remedy will be selected and implemented as soon as feasible and progress toward selecting the remedy will be documented in semiannual reports. As part of the process, one or more preferred remedial approaches will be developed based upon technology effectiveness under site conditions, implementability, and other considerations. As discussed above, a flexible and adaptive approach to groundwater remediation that begins with post-closure monitoring is planned.

7.3 Public Meeting Requirement in 40 CFR § 257.96(e)

Per 40 CFR § 257.96(e), IKEC will hold a public meeting to discuss ACM results, the remedy selection process, and selection of one or more preferred remedial approaches. The public meeting will be conducted at least 30 days prior to selection of a final remedy, in accordance with the above-referenced rule. Prior to the meeting, citizen and governmental stakeholders will be formally notified as to the schedule for the public meeting.

7.4 Final Remedy Selection

After selection of a remedy, a report documenting the remedy selection process will be prepared. The report will demonstrate how the remedy selection process was performed and how the selected remedial approach satisfies 40 CFR § 257.97 requirements.

8.0 REFERENCES

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TABLES

TABLE 4-1
GROUNDWATER MONITORING NETWORK
TYPE I RESIDUAL WASTE LANDFILL AND LANDFILL RUNOFF COLLECTION POND
CLIFTY CREEK STATION
MADISON, INDIANA

Monitoring Well ID	Designation	Date of Installation	Coordinates		Ground Elevation (ft)[2]	Top of Casing Elevation (ft)[2]	Top of Screen Elevation (ft)	Base of Screen Elevation (ft)	Total Depth From Top of Casing (ft)
			Northing	Easting					
CF-15-04	Background	12/3/2015	451482.81	569307.19	465.55	468.03	439.55	429.55	38.48
CF-15-05	Background	12/1/2015	447491.91	565533.64	439.85	442.58	422.85	412.85	29.73
CF-15-06	Background	11/30/2015	447026.92	565190.31	437.49	440.40	431.49	421.49	18.91
CF-15-07	Downgradient	11/23/2015	443135.08	562259.25	438.61	441.11	432.61	422.61	18.50
CF-15-08	Downgradient	11/19/2015	443219.57	562537.29	460.33	462.79	430.33	420.33	42.46
CF-15-09	Downgradient	11/25/2015	443445.96	562871.69	456.73	459.45	447.73	442.73	16.72
WBSP-15-01	Background	11/30/2015	449072.27	566322.12	466.93	469.36	458.93	448.93	20.43
WBSP-15-02	Background	11/11/2015	449803.91	566987.30	473.83	476.76	457.83	452.83	23.93

Notes:
1. The Well locations are referenced to the North American Datum (NAD83), east zone coordinate system.
2. Elevations are referenced to the North American Vertical Datum (NAVD) 1988

TABLE 4-2
SUMMARY OF POTENTIAL AND CONFIRMED APPENDIX III SSIs
TYPE I RESIDUAL WASTE LANDFILL AND LANDFILL RUNOFF COLLECTION POND
CLIFTY CREEK STATION
MADISON, INDIANA

Well Id	Parameter	1st Detection Monitoring Event	1st Detection Monitoring Resampling May 2018	1st Assessment Monitoring Event	1st Assessment Monitoring Resampling December 2018
		Potential SSI	Confirmed SSI (Yes/No)	Potential SSI	Confirmed SSI (Yes/No)
Type I Residual Waste Landfill & Landfill Runoff Collection Pond					
CF-15-07	pH	Yes	No	No	--
CF-15-08	Boron	Yes	Yes	Yes	Yes
	pH	Yes	No	No	--
CF-15-09	Boron	Yes	Yes	Yes	Yes
	pH	Yes	No	No	--

SSI: Statistically Significant Increase
mg/L: Milligrams per liter
-- : Not evaluated

TABLE 4-3
GROUNDWATER PROTECTION STANDARDS
LANDFILL RUNOFF COLLECTION POND
CLIFTY CREEK STATION
MADISON, INDIANA

Appendix IV Constituents			
Constituent	**Background**	**MCL/SMCL**	**Groundwater Protection Standard**
Antimony, Sb	0.2185 (μg/L)	6 (μg/L)	6 (μg/L)
Arsenic, As	4.47 (μg/L)	10 (μg/L)	10 (μg/L)
Barium, Ba	116.7 (μg/L)	2000 (μg/L)	2000 (μg/L)
Beryllium, Be	0.176 (μg/L)	4 (μg/L)	4 (μg/L)
Cadmium, Cd	0.08 (μg/L)	5 (μg/L)	5 (μg/L)
Chromium, Cr	8.4 (μg/L)	100 (μg/L)	100 (μg/L)
Cobalt, Co	2.578 (μg/L)	6 (μg/L)*	6 (μg/L)
Fluoride, F	0.5532 (mg/L)	4 (mg/L)	4 (mg/L)
Lithium, Li	0.103 (μg/L)	40 (μg/L)*	40 (μg/L)
Lead, Pb	2.023 (μg/L)	15 (μg/L)*	15 (μg/L)
Mercury, Hg	1.33 (μg/L)	2 (μg/L)	2 (μg/L)
Molybdenum, Mo	62.4 (μg/L)	100 (μg/L)*	100 (μg/L)
Radium 226 & 228 (combined)	8.02 (pCi/L)	5 (pCi/L)	8.02 (pCi/L)
Selenium, Se	0.44 (μg/L)	50 (μg/L)	50 (μg/L)
Thallium, Tl	0.1788 (μg/L)	2 (μg/L)	2 (μg/L)

* Established by EPA as part of 2018 decision.

TABLE 5-1
GRAIN SIZE ANALYSIS RESULTS
LANDFILL RUNOFF COLLECTION POND
CLIFTY CREEK STATION
MADISON, INDIANA

Boring No.	Sample Depth (feet)	70% Retention (30% Passing) Size (mm)	Filter Pack Size (mm)	Screen Mesh (inches)	Unified Soil Classification Symbol & Description	
CF-19-08D	30 - 40	0.0095	0.40	0.01	SM	Silty Sand
CF-19-08D	84 - 89	0.14	0.40	0.01	GC	Clayey Gravel with Sand
CF-19-15D	22 - 33	0.006	0.40	0.01	CL	Lean Clay with Sand
CF-19-15D	64 - 70	0.011	0.40	0.01	CL	Sandy Lean Clay with Gravel

Notes:
mm: Millimeters

TABLE 5-2
NEW MONITORING WELL CONSTRUCTION DETAILS
LANDFILL RUNOFF COLLECTION POND
CLIFTY CREEK STATION
MADISON, INDIANA

Monitoring Well ID	Designation	Date of Installation	Coordinates (1)		Ground Elevation² (feet)	Top of Casing Elevation² (feet)	Top of Screen BGS (feet)	Base of Screen BGS (feet)	Total Depth BGS (feet)
			Northing	Easting					
CF-19-08D	Downgradient	3/5-8/2019	443224.617	562551.003	460.68	463.49	84.00	89.00	89.00
CF-19-14	Downgradient	3/7-8/2019	443401.75	562901.929	452.29	454.88	10.00	20.00	20.00
CF-19-15	Downgradient	3/13/2019	442704.784	562483.023	441.10	443.61	23.00	33.00	33.00
CF-19-15D	Downgradient	3/11-12/2019	442713.897	562487.596	441.78	444.34	65.00	70.00	70.00

Notes:
1. The Well locations are referenced to the North American Datum (NAD83), east zone coordinate system.
2. Elevations are referenced to the North American Vertical Datum (NAVD) 1988
bgs: Below Ground Surface

TABLE 5-3
SUMMARY OF WELL DEVELOPMENT DATA
LANDFILL RUNOFF COLLECTION POND
CLIFTY CREEK STATION
MADISON, INDIANA

Well/Piezometer	Dates	Method	Volume (gallons)	Final Turbidity (NTU)
CF-19-08D	3/14-20/2019	Pump	52	4.75
CF-19-14	3/14-20/2019	Pump	16.5	3.84
CF-19-15	3/14-21/2019	Pump	24	4.35
CF-19-15D	3/14-21/2019	Pump	48	4.53

Notes:
NTU: Nephelometric Turbidity Unit

TABLE 5-4
SUMMARY OF GROUNDWATER ELEVATION DATA
MARCH 2019
LANDFILL RUNOFF COLLECTION POND
CLIFTY CREEK STATION
MADISON, INDIANA

Monitoring Well Designation	Top of Casing Elevation (feet)	Depth to Groundwater (feet)	Groundwater Elevation (feet)
CF-15-07	441.11	3.03	438.08
CF-15-08	462.79	18.10	444.69
CF-15-09	459.45	9.78	449.67
CF-19-14	454.88	8.15	446.73
CF-19-15	443.61	9.87	433.74
CF-19-8D	463.49	21.33	442.16
CF-19-15D	444.34	15.57	428.77

TABLE 5-5
SUMMARY OF SLUG TEST RESULTS
LANDFILL RUNOFF COLLECTION POND
CLIFTY CREEK STATION
MADISON, INDIANA

Well ID	Test	Analytical Method	K (ft/sec)	Mean K
Uppermost Aquifer				
Slug test performed May 2016				
CF-15-08	Falling Head #1	Bouwer-Rice	2.24E-03	2.44E-03
		Hvorslev	2.70E-03	
	Rising Head #1	Bouwer-Rice	2.52E-03	
		Hvorslev	3.04E-03	
	Falling Head #2	Bouwer-Rice	2.18E-03	
		Hvorslev	2.62E-03	
	Rising Head #2	Bouwer-Rice	1.90E-03	
		Hvorslev	2.29E-03	
Slug test performed April 2019				
CF-19-14	Falling Head #1	Bouwer-Rice	4.10E-06	3.80E-06
		Hvorslev	5.35E-06	
	Rising Head #2	Bouwer-Rice	2.50E-06	
		Hvorslev	3.26E-06	
CF-19-15	Falling Head #1	Bouwer-Rice	2.89E-05	3.02E-05
		Hvorslev	3.36E-05	
	Rising Head #1	Bouwer-Rice	2.67E-05	
		Hvorslev	3.25E-05	
	Falling Head #2	Bouwer-Rice	2.75E-05	
		Hvorslev	3.36E-05	
	Rising Head #2	Bouwer-Rice	2.64E-05	
		Hvorslev	3.22E-05	
			Mean K (ft/sec)	**8.23E-04**
Deep Aquifer				
CF-19-15D	Falling Head #1	Bouwer-Rice	4.73E-05	1.72E-05
		Hvorslev	5.16E-05	
	Rising Head #1	Bouwer-Rice	1.30E-06	
		Hvorslev	1.42E-06	
	Falling Head #2	Bouwer-Rice	1.54E-05	
		Hvorslev	1.67E-05	
	Rising Head #2	Bouwer-Rice	1.98E-06	
		Hvorslev	2.16E-06	
CF-19-08D	Falling Head #1	Bouwer-Rice	1.36E-05	8.96E-06
		Hvorslev	1.43E-05	
	Rising Head #1	Bouwer-Rice	4.00E-06	
		Hvorslev	4.20E-06	
	Falling Head #2	Bouwer-Rice	1.15E-05	
		Hvorslev	1.21E-05	
	Rising Head #2	Bouwer-Rice	5.82E-06	
		Hvorslev	6.12E-06	
			Mean K (ft/sec)	**1.31E-05**

TABLE 5-6
SUMMARY OF GROUNDWATER VELOCITY CALCULATIONS
MARCH 2019
LANDFILL RUNOFF COLLECTION POND
CLIFTY CREEK STATION
MADISON, INDIANA

Well Pair		h_1 (feet)	h_2 (feet)	d (feet)	K (feet/day)	n	i	V (feet/day)
Uppermost Aquifer								
CF-15-08 (h_1)	CF-19-15 (h_2)	444.69	433.74	523	71.11	0.2	0.0209	7.43
Deep Aquifer								
CF-19-08D (h_1)	CF-19-15D (h_2)	442.16	428.77	523	1.13	0.2	0.0256	0.1446

h_1 = Head elevation in well #1
h_2 = Head elevation in well #2
d = distance between wells
K = Hydraulic conductivity
n = effective porosity
i = Horizontal Hydraulic Gradient
V = Groundwater Velocity

Horizontal Hydraulic Gradient:

$$i = \frac{h_1 - h_2}{d}$$

Groundwater Velocity:

$$V = K\left(\frac{i}{n}\right)$$

TABLE 5-7
SUMMARY OF GROUNDWATER ANALYTICAL RESULTS
MARCH 2019
LANDFILL RUNOFF COLLECTION POND
CLIFTY CREEK STATION
MADISON, INDIANA

Parameter	Units	GWPS	CF-15-07	CF-15-08	CF-15-09	CF-19-08D	CF-19-14	CF-19-15	CF-19-15D
Appendix III Constituents									
Boron, B	mg/L	--	0.045 J	9.8	6.7	0.099 J	6.3	0.15	0.078 J
Calcium, Ca	mg/L	--	150	140	160	44	170	240	47
Chloride, Cl	mg/L	--	5.6	14	3	6.6	5.0	13	7.4
Fluoride, F	mg/L	--	0.21	0.37	0.31	0.52	0.22	0.15	0.32
pH	s.u.	--	7.04	7.05	7.19	7.8	7.2	6.8	7.7
Sulfate, SO4	mg/L	--	11	240	260	9.1	230	150	16
Total Dissolved Solids (TDS)	mg/L	--	620	680	620	270	610	950	350
Appendix IV Constituents									
Antimony, Sb	ug/L	6	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Arsenic, As	ug/L	10	4.6 J	<5.0	<5.0	4.1 J	<5.0	<5.0	53
Barium, Ba	ug/L	2000	81	60	14	91	53	110	150
Beryllium, Be	ug/L	4	<1.0	<1.0	1.5	0.66 J	<1.0	<1.0	<1.0
Cadmium, Cd	ug/L	5	<1.0	<1.0	0.23 J	<1.0	<1.0	<1.0	<1.0
Chromium, Cr	ug/L	100	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Cobalt, Co	ug/L	9.745	2.4	0.19 J	0.38 J	0.39 J	3.4	1.9	0.97 J
Fluoride, F	mg/L	4	0.21	0.37	0.31	0.52	0.22	0.15	0.32
Lithium, Li	mg/L	0.04	<1.0	<1.0	<1.0	0.0035 J	<0.008	0.0029 J	0.004 J
Lead, Pb	ug/L	15	0.0017 J	0.017	0.0087	<1.0	<1.0	<1.0	<1.0
Mercury, Hg	ug/L	2	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Molybdenum, Mo	ug/L	100	4.9 J	380	100	31	12	1.1 J	49
Radium 226 & 228 (combined)	pCi/L	5	2.34	0.413	<5.0	<0.238	<0.305	<0.193	0.332
Selenium, Se	ug/L	50	<5.0	<5.0	1.2 J	<5.0	<5.0	1.8 J	<5.0
Thallium, Tl	ug/L	2	<1.0	<1.0	0.2 J	<1.0	<1.0	<1.0	<1.0

Notes:
mg/L: Milligrams per liter
s.u.: Standard Units
ug/L: Micrograms per liter
pCi/L: Picocuries per liter

TABLE 6-1
SOURCE CONTROL TECHNOLOGIES SCREENING MATRIX - 40 CFR § 257.96(c) REQUIREMENTS
LANDFILL RUNOFF COLLECTION POND
CLIFTY CREEK STATION
MADISON, INDIANA

	Source Control Technologies		
	Dewatering of Pond Water	**Engineered Cover System**	**Excavation of Ash**
257.96(c)(1)			
Performance	Low	Medium	High
Reliability	Low	Medium	High
Ease of Implementation	Low Water Removal, Treatment & Discharge Required	Medium Field Construction Required	High Field Construction Required
Potential Safety Impacts	Low Field Construction Required	Medium Field Construction Required	High Field Construction Required
Potential Cross-Media Impacts	Medium	Low	Medium
Potential Impacts from Control of Exposure to Residual Constituents	Low	Low	Low
257.96(c)(2)			
Time To Begin Remedy	6 months to 1 year	1 to 1.5 years	1 to 1.5 years
Time To Complete Remedy	2 to 3 years	2 to 3 years	5 to 7 years
257.96(c)(3)			
State, Local or other Environmental Permit Requirements that May Impact Implementation	Requires Approval from IDEM	Requires Approval from IDEM	Requires Approval from IDEM
Additional Information	Required for In-Place Closure or Closure by Removal	Ash Remains in Place as Long-Term Source for Groundwater	Groundwater Issues Need to be Addressed

Notes:
Relative assessments (low, medium, high) are based on experience and professional judgement

TABLE 6-2
IN-SITU AND EX-SITU GROUNDWATER REMEDIAL TECHNOLOGIES SCREENING MATRIX - 40 CFR § 257.96(c) REQUIREMENTS
LANDFILL RUNOFF COLLECTION POND
CLIFTY CREEK STATION
MADISON, INDIANA

	In-Situ Groundwater Remedial Technologies				*Ex-Situ Groundwater Remedial Technologies*		
	Monitored Natural Attenuation	**Groundwater Migration Barriers**	**In-situ Chemical Stabilization**	**Permeable Reactive Barrier**	**Conventional Well System**	**Horizontal Well System**	**Trenching System**
257.96(c)(1)							
Performance	High	Low	Low	Low	High	Low Significant Water Level Fluctuations Reduce Effectiveness of Horizontal Wells	High
Reliability	High	Low	Medium	Medium	High Long Term O&M Required	Low Significant Issues with Water Level Fluctuations	High Long Term O&M Required
Ease of Implementation	High	Low	Low	Low	High Drilling and Limited Field Construction Required	Medium Drilling and Limited Field Construction Required	Low Trench Construction Required
Potential Safety Impacts	Low	Medium Field Construction Required	Medium Field Construction Required	Medium Field Construction Required	Medium Drilling Required	Medium Drilling Required	Medium Trench Construction Required
Potential Cross-Media Impacts	Low	Medium	Low	Low	Medium	Medium	Medium
Potential Impacts from Control of Exposure to Residual Constituents	Low	Low	Low	Low	Low	Low	Low
257.96(c)(2)							
Time To Begin Remedy*	3 months	1 to 1.5 years	1 to 1.5 years	1 to 1.5 years	6 months to 1 year	6 months to 1 year	6 months to 1 year
Time To Complete Remedy	Highly Variable Further Evaluation Required	Highly Variable Further Evaluation Required	Highly Variable Further Evaluation Required	Highly Variable Further Evaluation Required	Highly Variable Further Evaluation Required	Highly Variable Further Evaluation Required	Highly Variable Further Evaluation Required
257.96(c)(3)							
State, Local or other Environmental Permit Requirements that May Impact Implementation	Requires Coordination with IDEM	Requires Approval from IDEM	Requires Approval from IDEM	Requires Approval from IDEM	Requires Approval from IDEM	Requires Approval from IDEM	Requires Approval from IDEM
Additional Information	Groundwater F&T Modeling Required to Evaluate the Timing for This Approach for Molybdenum	Groundwater Flow Modeling Required to Fully Evaluate This Approach	Bench Scale Testing Required to Further Evaluate Applicability for Molybdenum	Bench Scale Testing Required to Further Evaluate Applicability for Molybdenum	Groundwater Flow Modeling Required to Fully Evaluate This Approach	Groundwater Flow Modeling Required to Fully Evaluate This Approach	Groundwater Flow Modeling Required to Fully Evaluate This Approach

Notes:
Relative assessments (low, medium, high) are based on experience and professional judgement
*The time to begin the remedy is based on the time after closure of the unit.

FIGURES

1200' 0' 1200' 2400'
SCALE: 1"= 1200'

DRAWN BY	JM
DATE	
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JOB NO.	2019042-8-CLIFTY
DWG FILE	2019_IKEC_Clifty_ACM_Fig 2-1_location map.dwg
DRAWING SCALE	AS SHOWN

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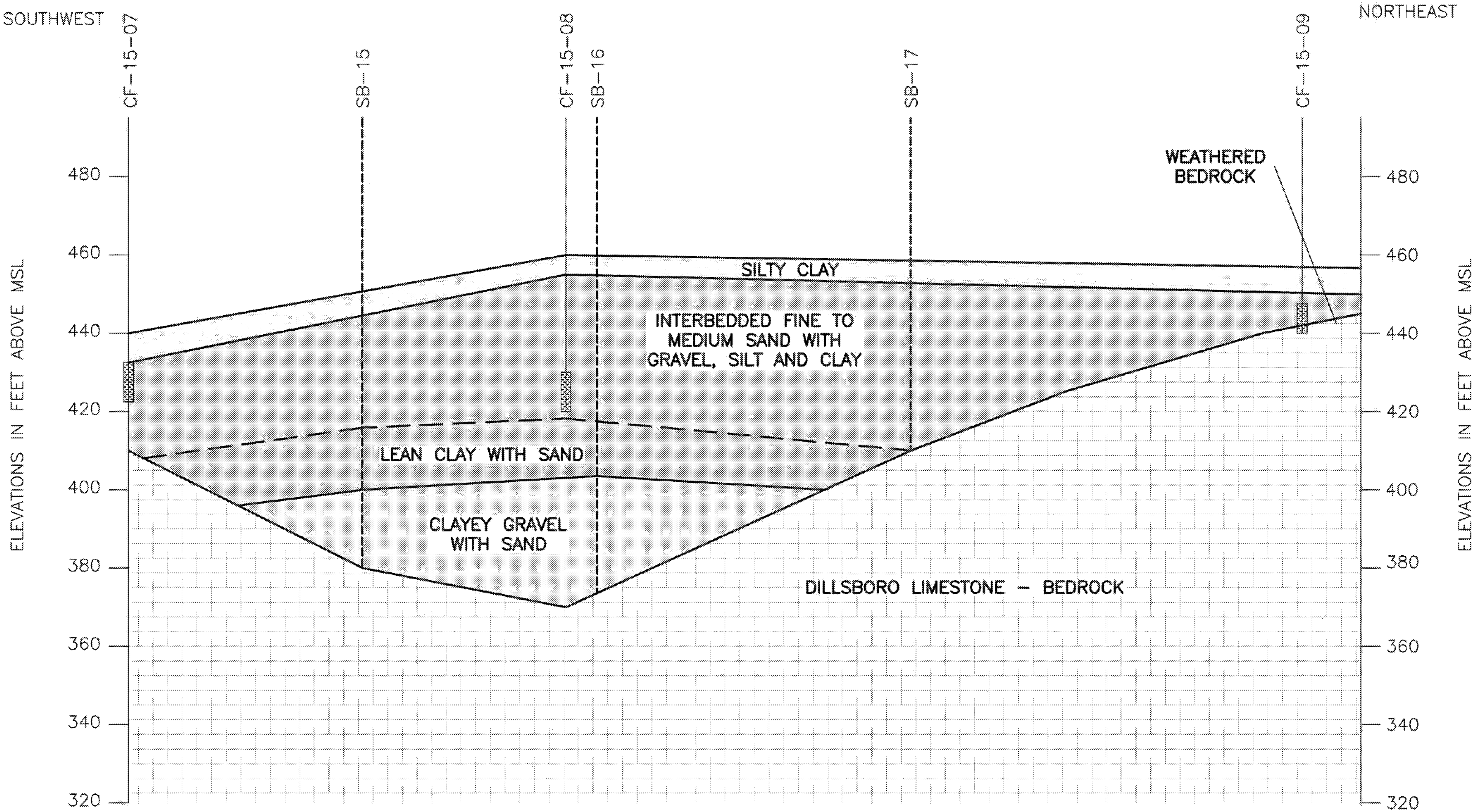
INDIANA–KENTUCKY ELECTRIC CORPORATION

CLIFTY CREEK STATION
MADISON, INDIANA
SITE LOCATION MAP

DRAWING NAME: FIGURE 2–1
REV. 0

Plot: 08/09/2019 10:24 _PROGRAMS–IKEC\Clifty Creek–CCR Program\CAD\2019 Assessment of Corrective Measures\2019_IKEC_Clifty_ACM_Fig 2-1_location map.dwg



NOTES:

1) CROSS-SECTION COMPILED USING AGES BORING AND WELL LOGS, SOIL BORING INFORMATION FROM THE 2007 LITIGATION REPORT AND STANTEC DATA FROM THE LRCP STABILITY ASSESSMENT REPORT.

2) THE APPROXIMATE LOCATION OF THE CROSS-SECTION IS ILLUSTRATED ON FIGURE 3-2.

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DATE	
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JOB NO.	2019042-8-CLIFTY
DWG FILE	2019_IKEC_Clifty_ACM_Fig 3-1_X-Section_LRCP.dwg
DRAWING SCALE	NOT TO SCALE

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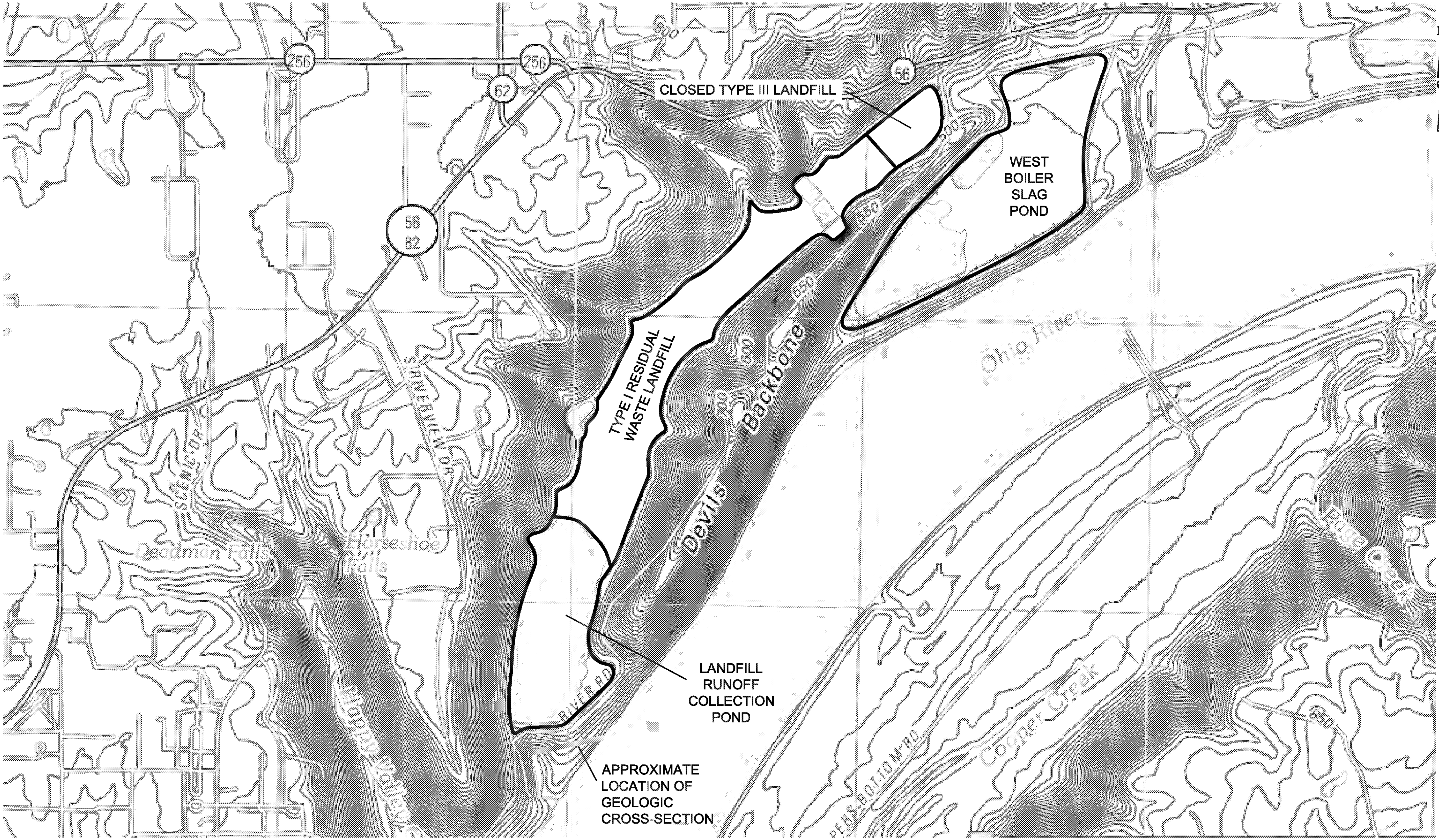
INDIANA-KENTUCKY ELECTRIC CORPORATION

CLIFTY CREEK STATION
MADISON, INDIANA
GEOLOGIC CROSS-SECTION AT
LANDFILL RUNOFF COLLECTION POND

DRAWING NAME: FIGURE 3-1
REV. 0

Plot: 09/09/2019 14:37 _PROGRAM-IKEC\Clifty Creek-CCR Program\CAD\2019 Assessment of Corrective Measures\2019_IKEC_Clifty_ACM_Fig 3-1_X-Section_LRCP.dwg



APPROXIMATE LOCATION OF THE GEOLOGIC CROSS-SECTION (FIGURE 3-1).

SOURCE: USGS MADISON WEST 7.5 MINUTE TOPOGRAHIC QUADRANGLE, 2010.

DRAWN BY: JM	AGES	INDIANA-KENTUCKY ELECTRIC CORPORATION	
DATE	Applied Geology And Environmental Science, Inc.	CLIFTY CREEK STATION MADISON, INDIANA TOPOGRAPHIC MAP	
CHECKED BY	2402 Hookstown Grade Road, Suite 200 Clinton, PA 15026 412.264.6453		
JOB NO.: 2019042-8-CLIFTY			
DWG FILE: 2019_IKEC_Clifty_ACM_Fig 3-2_USGS_topo_map.dwg			
DRAWING SCALE: NOT TO SCALE		DRAWING NAME: FIGURE 3-2	REV. 0

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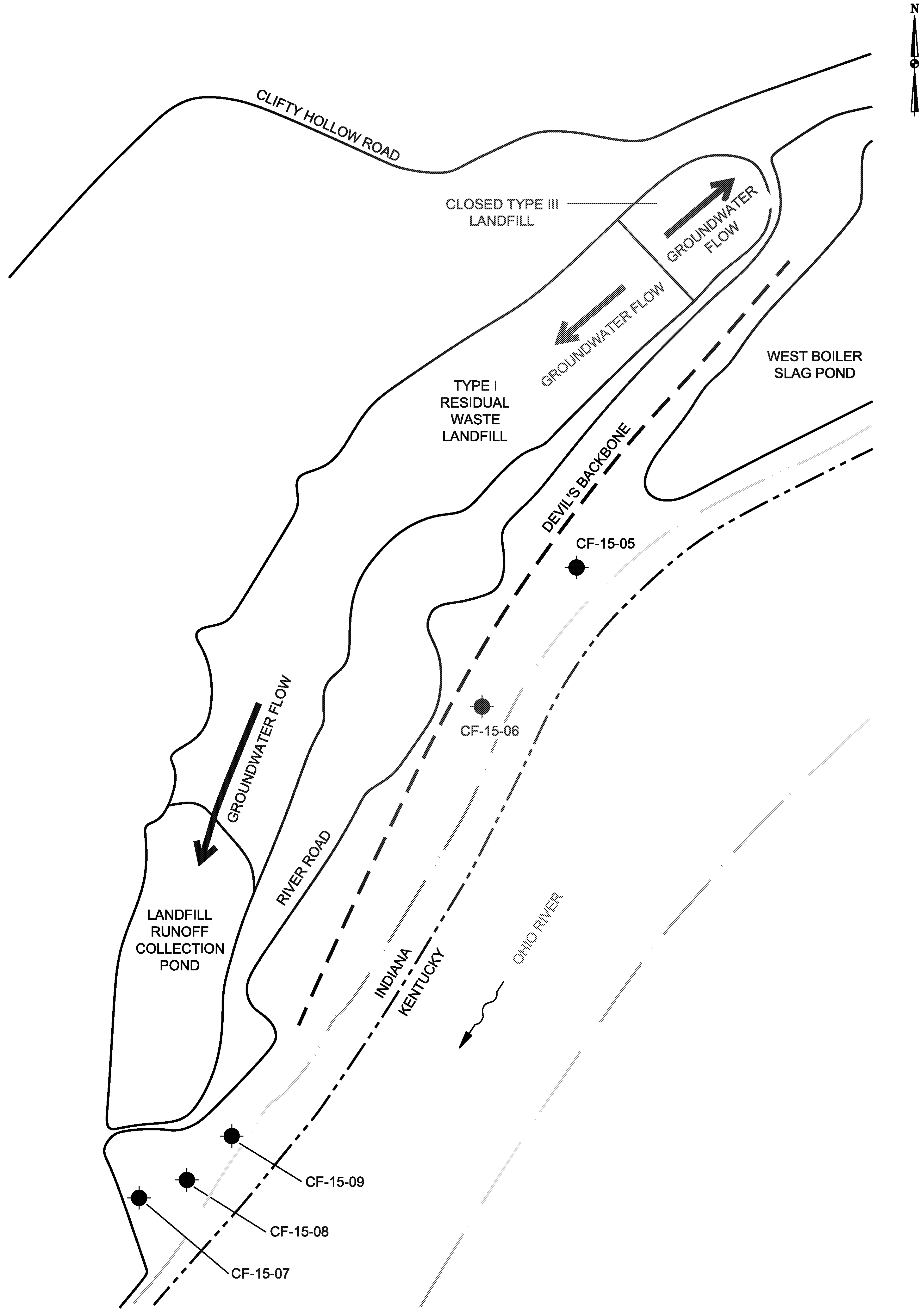

LEGEND:

MONITORING WELL LOCATION

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JOB NO.	2019042-8-CLIFTY
DWG FILE	2019_IKEC_Clifty_ACM_Fig 3-3_Gen_GW Flow Map.dwg
DRAWING SCALE	NOT TO SCALE

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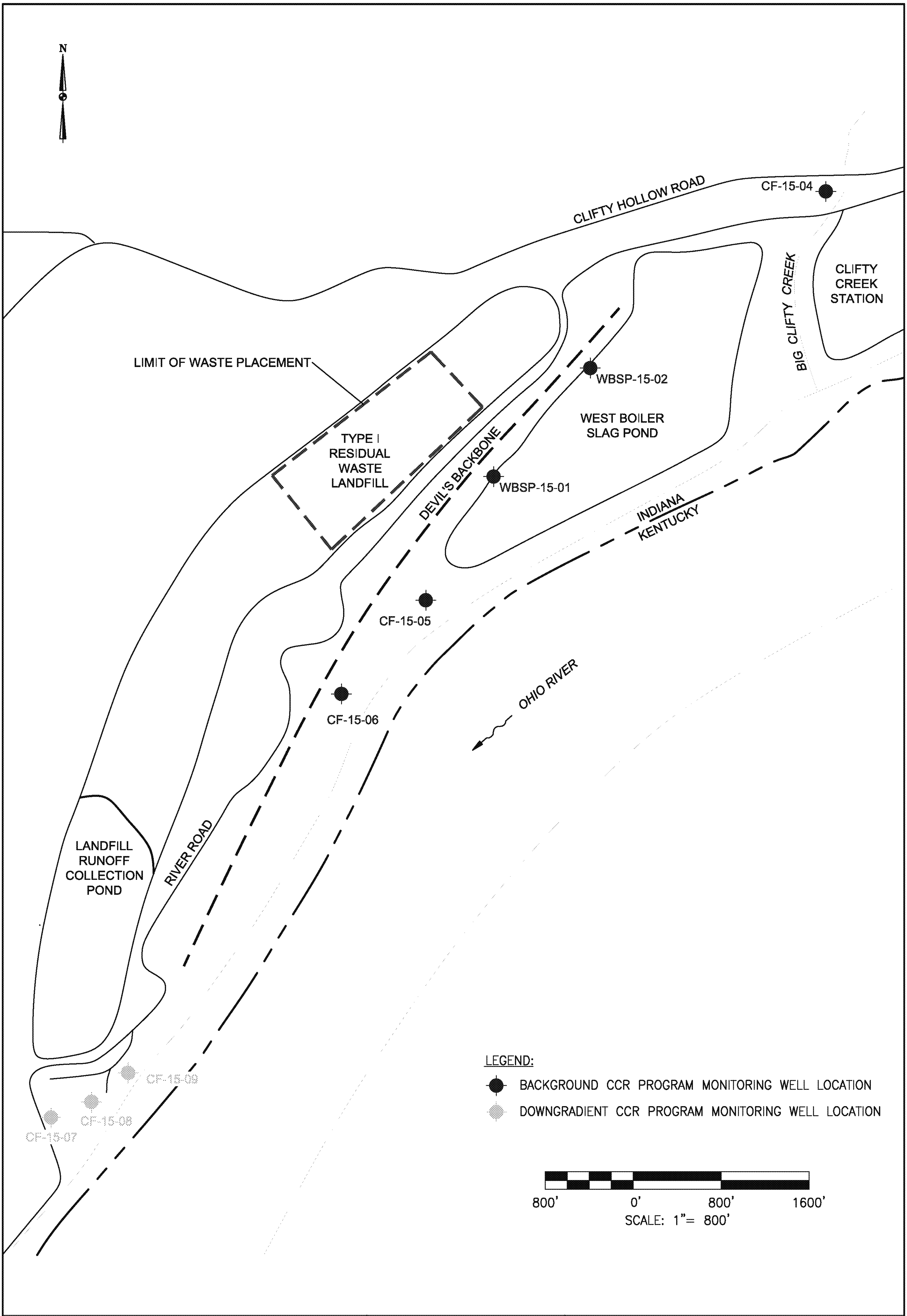
CLIFTY CREEK STATION
MADISON, INDIANA
TYPE I RESIDUAL WASTE LANDFILL AND
LANDFILL RUNOFF COLLECTION POND
EXISTING MONITORING WELL LOCATIONS AND
GENERALIZED GROUNDWATER FLOW MAP

DRAWING NAME: FIGURE 3–3

REV. 0

Plot: 08/09/2019 10:41 _PROGRAMS-IKEC\Clifty Creek-CCR Program\CAD\2019 Assessment of Corrective Measures\2019_IKEC_Clifty_ACM_Fig 3-3_Gen_GW Flow Map.dwg



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JOB NO.	2019042-8-CLIFTY
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DRAWING SCALE	NOT TO SCALE

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CLIFTY CREEK STATION
MADISON, INDIANA
TYPE I RESIDUAL WASTE LANDFILL AND
LANDFILL RUNOFF COLLECTION POND
EXISTING MONITORING WELL LOCATIONS

DRAWING NAME: FIGURE 4-1
REV. 0

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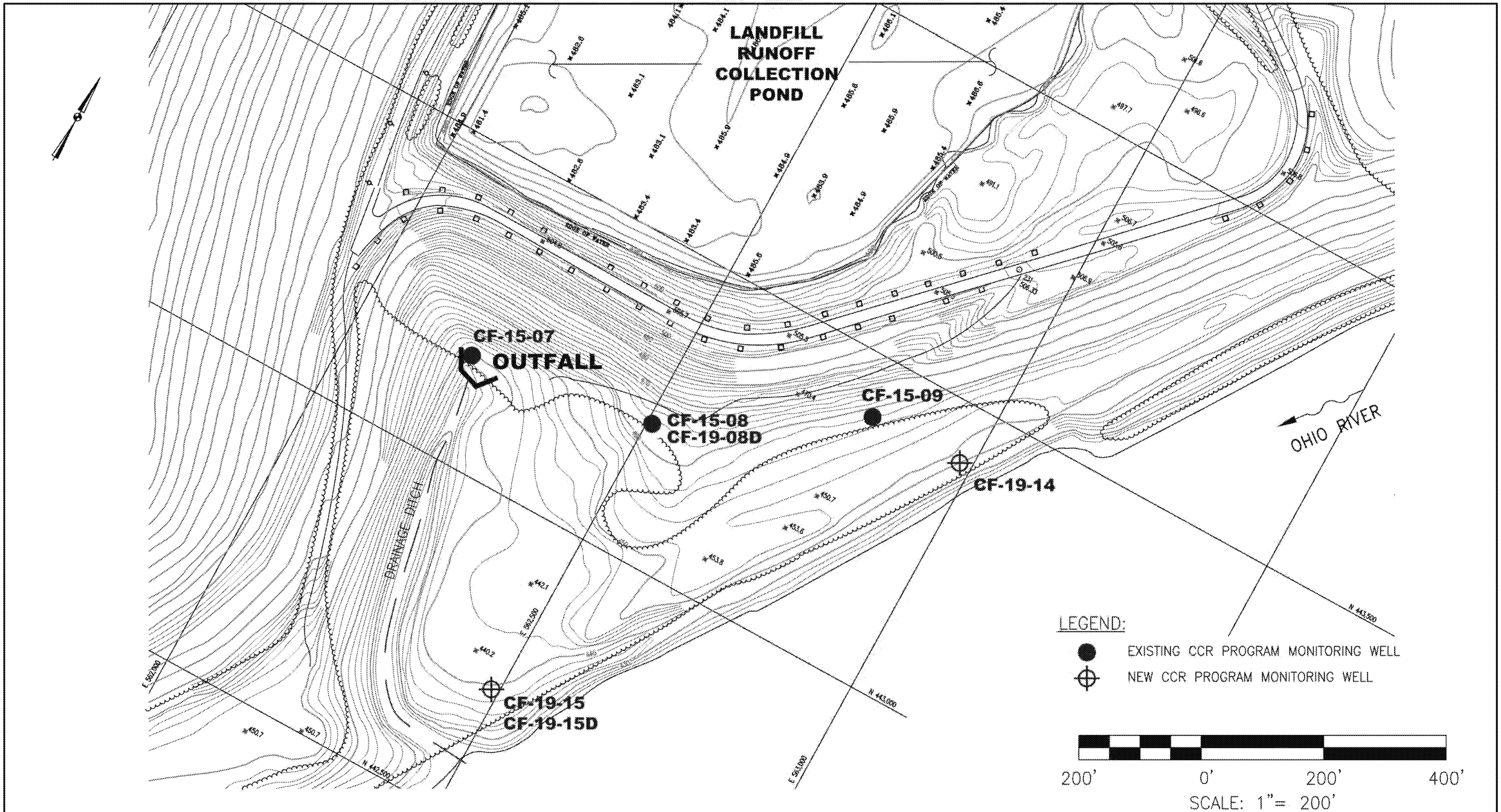

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DWG FILE	2019_IKEC_Clifty_ACM_Fig 5-1_MW locs.dwg
DRAWING SCALE	AS SHOWN

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CLIFTY CREEK STATION
MADISON, INDIANA
CCR PROGRAM
EXISTING AND NEW MONITORING WELL LOCATIONS

DRAWING NAME: FIGURE 5-1 REV. 0

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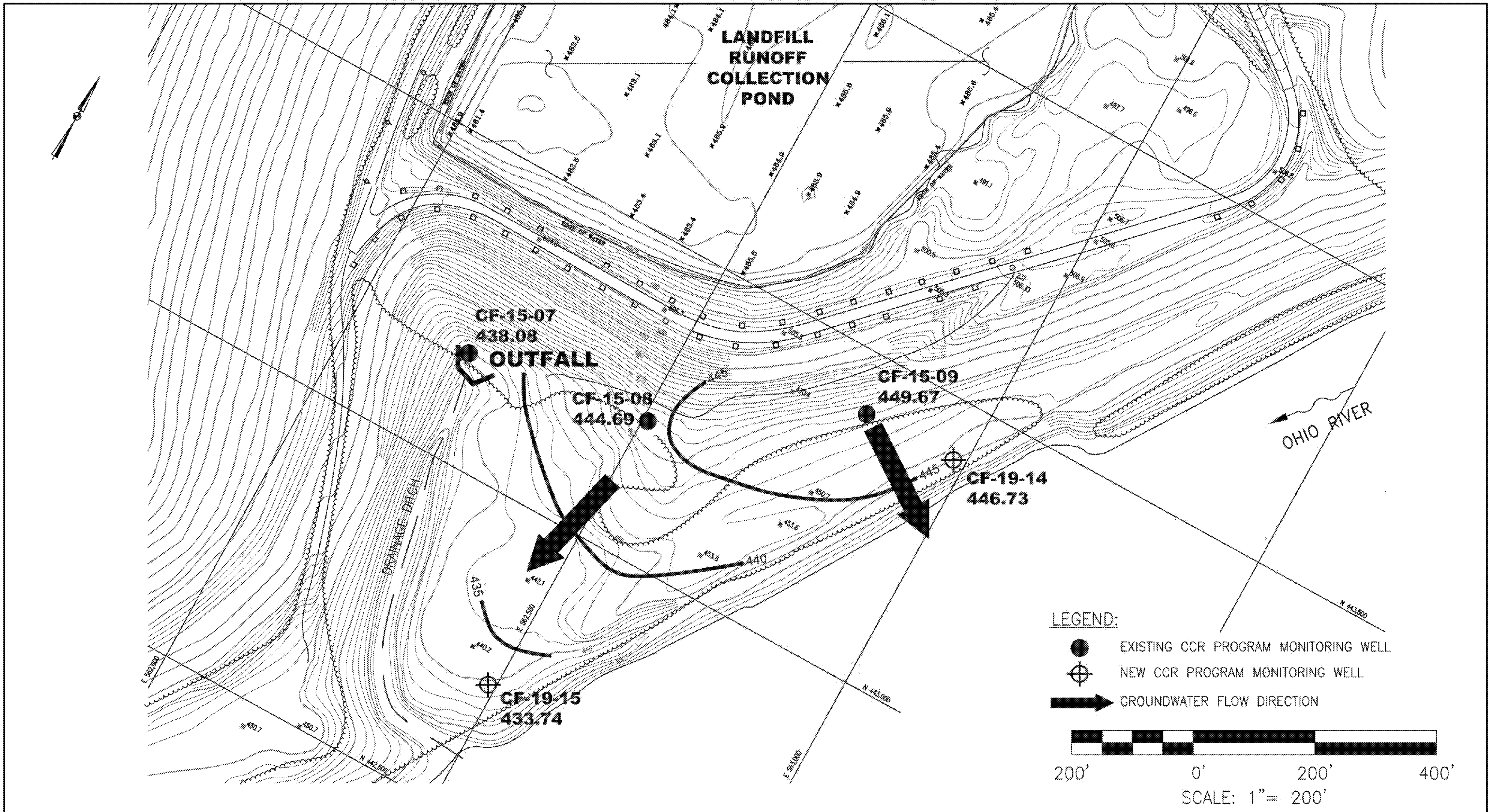

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DATE	2402 Hookstown Grade Road, Suite 200 Clinton, PA 15026 412.264.6453	CLIFTY CREEK STATION MADISON, INDIANA CCR PROGRAM GROUNDWATER FLOW - UPPERMOST AQUIFER MARCH 2019	
CHECKED BY			
JOB NO. 2019108-CLIFTY			
DWG. FILE 2019_IKEC_Clifty_ACM_Fig 5-2_GW Flow-Upper Aquifer.dwg		DRAWING NAME FIGURE 5-2	REV. 0
DRAWING SCALE AS SHOWN			

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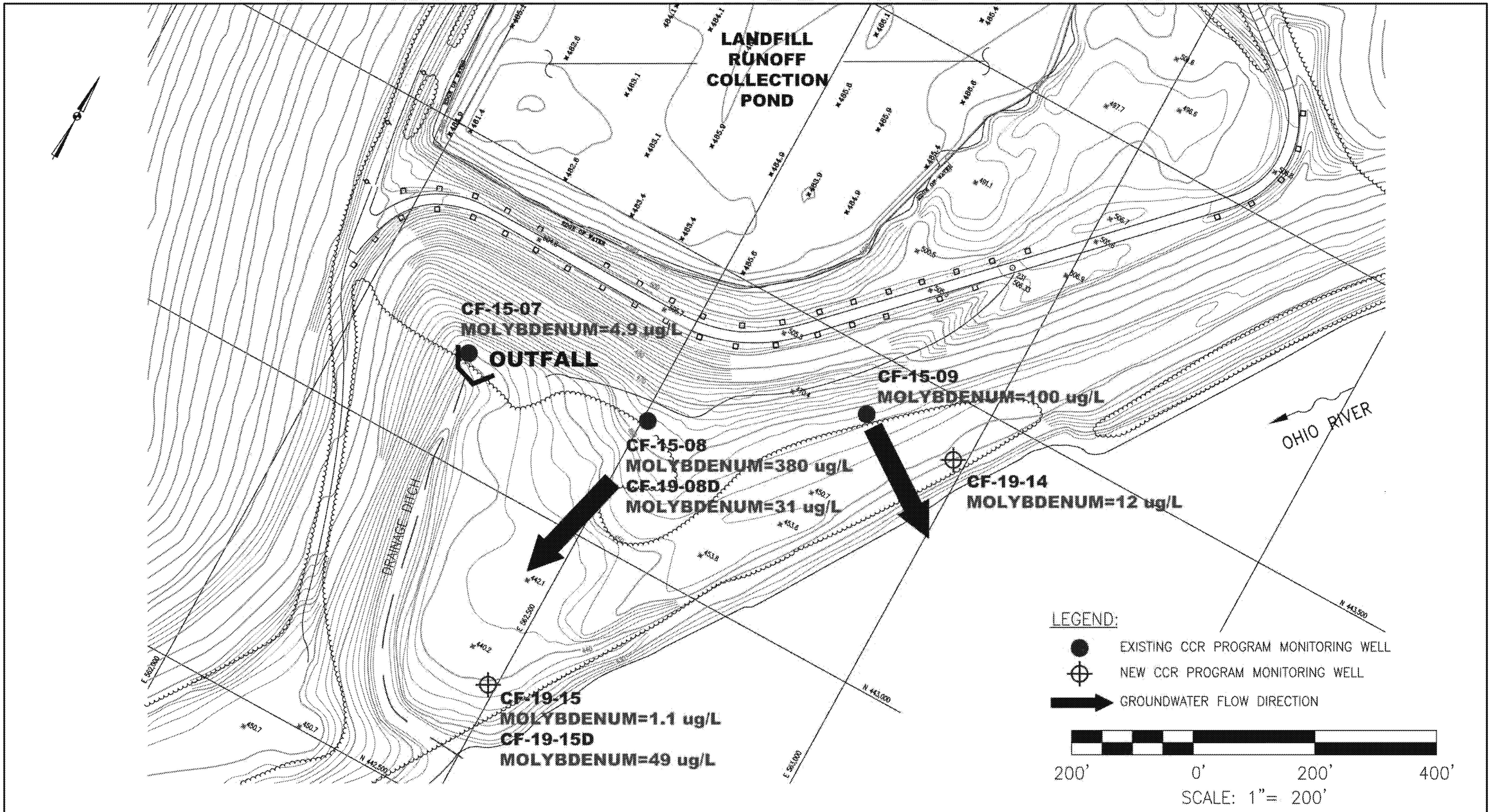

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DATE	
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DRAWING SCALE	AS SHOWN

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CLIFTY CREEK STATION
MADISON, INDIANA
CCR PROGRAM
MOLYBDENUM CONCENTRATIONS IN GROUNDWATER
MARCH 2019

DRAWING NAME: FIGURE 5-3
REV. 0

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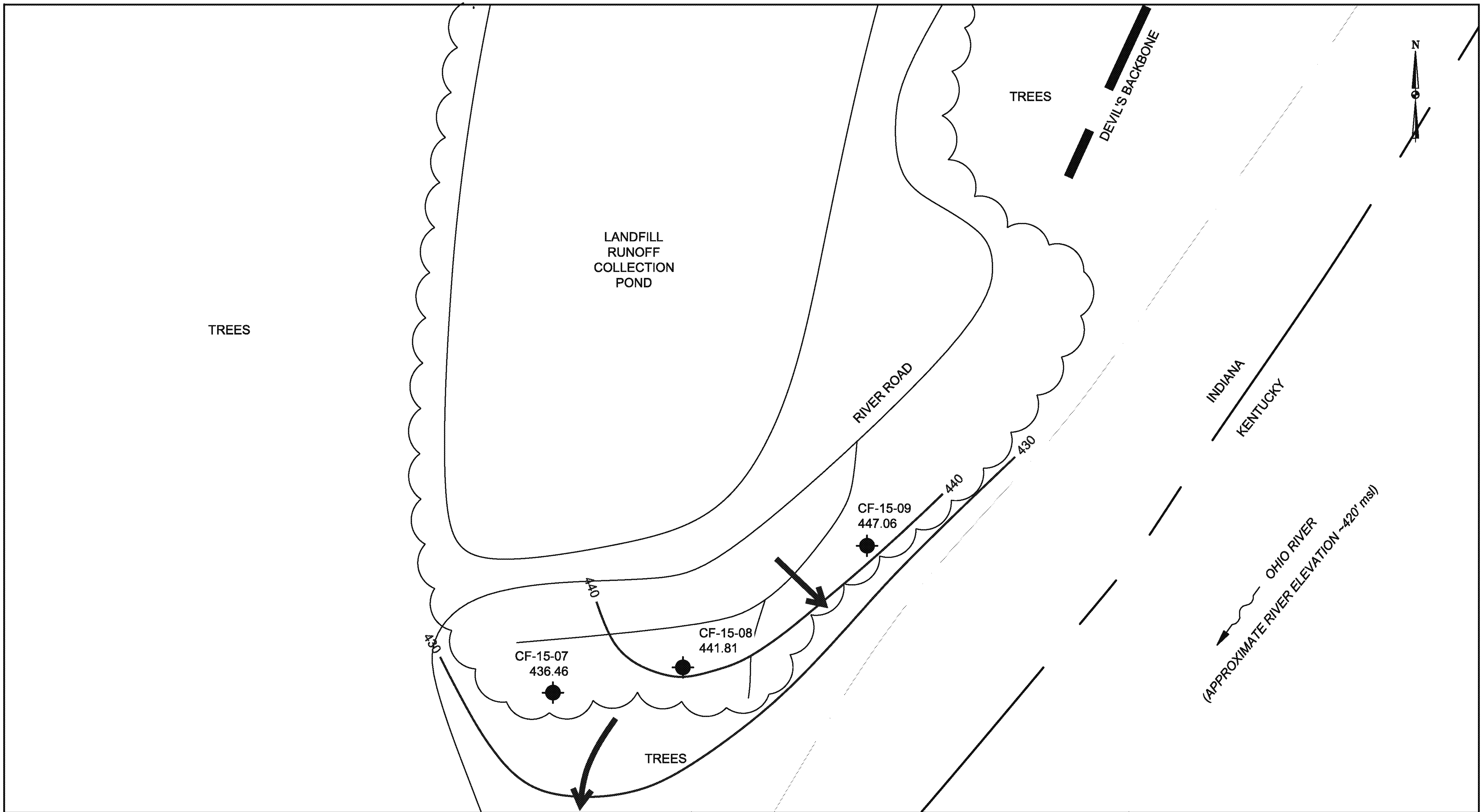
APPENDIX A

GENERALIZED GROUNDWATER FLOW MAPS FOR 2018



LEGEND:

MONITORING WELL LOCATION

GROUNDWATER FLOW DIRECTION

200' 0' 200' 400'

SCALE: 1"= 200'

DRAWN BY	JM
DATE	
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JOB NO.	2019042-8-CLIFTY
DWG FILE	2019_IKEC_Clifty_ACM_Appx A_MAR18.dwg
DRAWING SCALE	AS SHOWN

AGES

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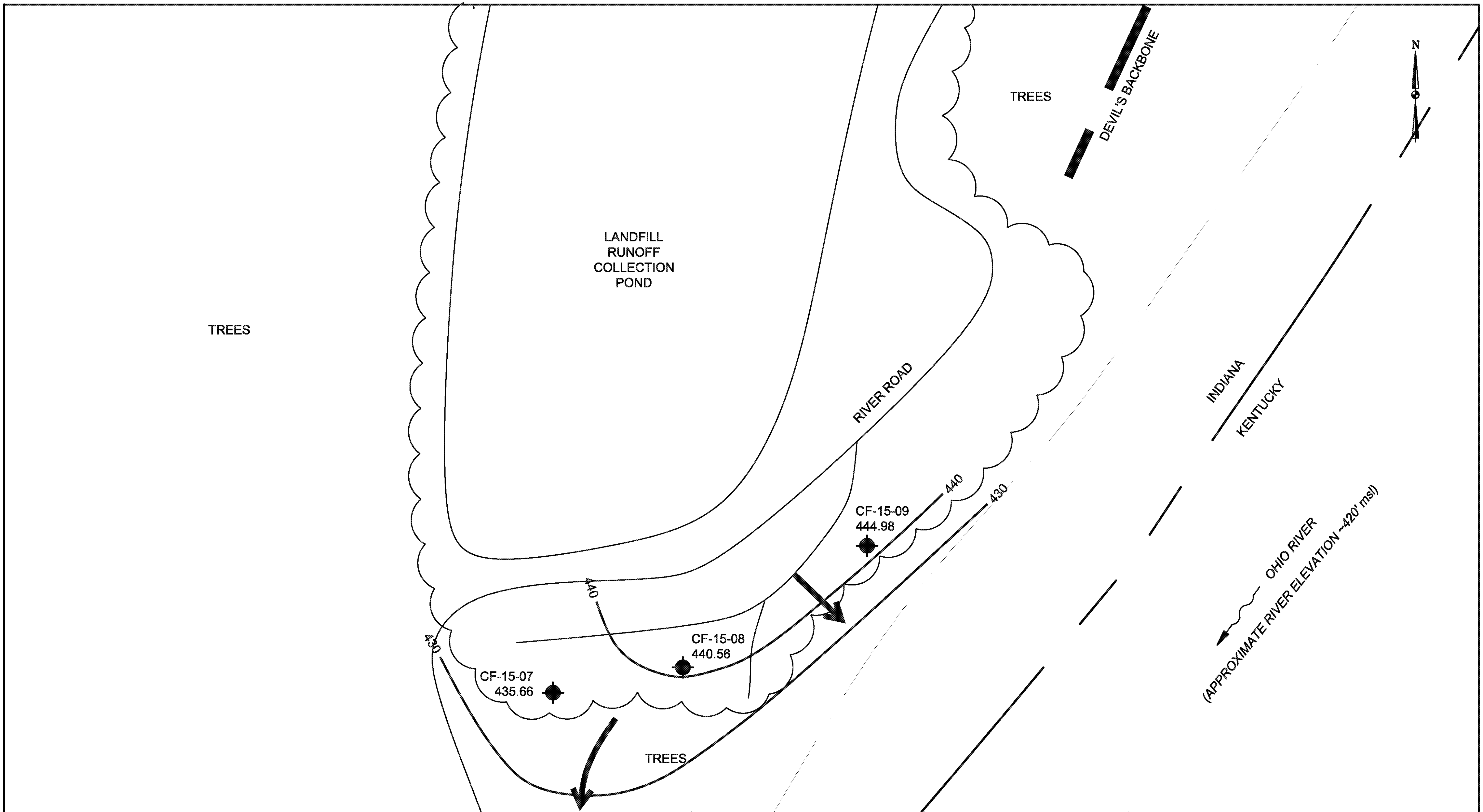
INDIANA-KENTUCKY ELECTRIC CORPORATION

CLIFTY CREEK STATION
MADISON, INDIANA
LANDFILL RUNOFF COLLECTION POND
GENERALIZED GROUNDWATER FLOW MAP
MARCH 2018

DRAWING NAME: FIGURE A-1

REV. 0

Plot: 08/09/2019 13:20 _PROGRAMS-IKEC\Clifty Creek-CCR Program\CAD\2019 Assessment of Corrective Measures\Appx A\2019_IKEC_Clifty_ACM_Appx A_MAR18.dwg\A-1



LEGEND:

- MONITORING WELL LOCATION
- GROUNDWATER FLOW DIRECTION

200' 0' 200' 400'

SCALE: 1"= 200'

DRAWN BY	JM
DATE	
CHECKED BY	
JOB NO.	2019042-8-CLIFTY
DWG FILE	2019_IKEC_Clifty_ACM_Appx A_OCT18.dwg
DRAWING SCALE	AS SHOWN

AGES

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INDIANA–KENTUCKY ELECTRIC CORPORATION

CLIFTY CREEK STATION
MADISON, INDIANA
LANDFILL RUNOFF COLLECTION POND
GENERALIZED GROUNDWATER FLOW MAP
OCTOBER 2018

DRAWING NAME: FIGURE A–2

REV. 0

Plot: 08/09/2019 13:23 _PROGRAMS–IKEC\Clifty Creek–CCR Program\CAD\2019 Assessment of Corrective Measures\Appx A\2019_IKEC_Clifty_ACM_Appx A_OCT18.dwg\A–2

APPENDIX B

ANALYTICAL RESULTS FOR 2018 GROUNDWATER MONITORING

CF-15-04
SUMMARY OF 2018 ANALYTICAL RESULTS
Indiana-Kentucky Electric Corporation
Clifty Creek Station
Madison, Indiana

Parameter	UTL	GWPS	Mar-18	Oct-18
Appendix III Constituents				
Boron, B (mg/L)	5.02	--	0.043	0.09 J
Calcium, Ca (mg/L)	314.4	--	106	74.2
Chloride, Cl (mg/L)	282	--	282	50.2
Fluoride, F (mg/L)	0.5477	--	0.09	0.12
pH (s.u.)	5.57 - 10.36	--	10.06	7.76
Sulfate, SO4 (mg/L)	634	--	35.2	34.4
Total Dissolved Solids (TDS) (mg/L)	1290	--	788	377
Appendix IV Constituents				
Antimony, Sb (ug/L)	0.2556	6	NA	0.1 J
Arsenic, As (ug/L)	4.47	10	NA	0.38
Barium, Ba (ug/L)	129.1	2000	NA	57.5
Beryllium, Be (ug/L)	0.934	4	NA	0.1 U
Cadmium, Cd (ug/L)	0.3	5	NA	0.05 U
Chromium, Cr (ug/L)	8.4	100	NA	0.2 J
Cobalt, Co (ug/L)	4.01	6	NA	0.114
Fluoride, F (ug/L)	0.5477	4	0.09	0.12
Lithium, Li (ug/L)	0.2443	40	NA	0.009 J
Lead, Pb (ug/L)	3.703	15	NA	0.141
Mercury, Hg (ug/L)	1.16	2	NA	0.003 J
Molybdenum, Mo (ug/L)	62.4	100	NA	2.54
Radium 226 & 228 (combined) (pCi/L)	5.523	8.02	NA	0.62
Selenium, Se (ug/L)	1.9	50	NA	0.2 J
Thallium, Tl (ug/L)	0.25	2	NA	0.5 U

Notes:
NA = Sample not analyzed for the parameter
UTL: Upper Threshold Limit
GWPS: Groundwater Protection Standard

CF-15-05
SUMMARY OF 2018 ANALYTICAL RESULTS
Indiana-Kentucky Electric Corporation
Clifty Creek Station
Madison, Indiana

Parameter	UTL	GWPS	Mar-18	Oct-18
Appendix III Constituents				
Boron, B (mg/L)	5.02	--	0.209	0.174
Calcium, Ca (mg/L)	314.4	--	103	113
Chloride, Cl (mg/L)	282	--	31.5	30.2
Fluoride, F (mg/L)	0.5477	--	0.47	0.48
pH (s.u.)	5.57 - 10.36	--	9.56	7.18
Sulfate, SO4 (mg/L)	634	--	44.3	40.9
Total Dissolved Solids (TDS) (mg/L)	1290	--	528	502
Appendix IV Constituents				
Antimony, Sb (ug/L)	0.2556	6	NA	0.02 J
Arsenic, As (ug/L)	4.47	10	NA	0.91
Barium, Ba (ug/L)	129.1	2000	NA	58.8
Beryllium, Be (ug/L)	0.934	4	NA	0.1 U
Cadmium, Cd (ug/L)	0.3	5	NA	0.04 J
Chromium, Cr (ug/L)	8.4	100	NA	0.228
Cobalt, Co (ug/L)	4.01	6	NA	0.463
Fluoride, F (ug/L)	0.5477	4	0.47	0.48
Lithium, Li (ug/L)	0.2443	40	NA	0.01 J
Lead, Pb (ug/L)	3.703	15	NA	0.21
Mercury, Hg (ug/L)	1.16	2	NA	0.003 J
Molybdenum, Mo (ug/L)	62.4	100	NA	2.94
Radium 226 & 228 (combined) (pCi/L)	5.523	8.02	NA	0.484
Selenium, Se (ug/L)	1.9	50	NA	0.06 J
Thallium, Tl (ug/L)	0.25	2	NA	0.5 U

Notes:
NA = Sample not analyzed for the parameter
UTL: Upper Threshold Limit
GWPS: Groundwater Protection Standard

CF-15-06
SUMMARY OF 2018 ANALYTICAL RESULTS
Indiana-Kentucky Electric Corporation
Clifty Creek Station
Madison, Indiana

Parameter	UTL	GWPS	Mar-18	Oct-18
Appendix III Constituents				
Boron, B (mg/L)	5.02	--	0.16	0.05 J
Calcium, Ca (mg/L)	314.4	--	125	184
Chloride, Cl (mg/L)	282	--	7.76	8.21
Fluoride, F (mg/L)	0.5477	--	0.2	0.21
pH (s.u.)	5.57 - 10.36	--	10.36	7.89
Sulfate, SO4 (mg/L)	634	--	112	102
Total Dissolved Solids (TDS) (mg/L)	1290	--	630	696
Appendix IV Constituents				
Antimony, Sb (ug/L)	0.2556	6	NA	0.07 J
Arsenic, As (ug/L)	4.47	10	NA	1.21
Barium, Ba (ug/L)	129.1	2000	NA	149
Beryllium, Be (ug/L)	0.934	4	NA	0.934
Cadmium, Cd (ug/L)	0.3	5	NA	0.3
Chromium, Cr (ug/L)	8.4	100	NA	6.81
Cobalt, Co (ug/L)	4.01	6	NA	8.27
Fluoride, F (ug/L)	0.5477	4	0.2	0.21
Lithium, Li (ug/L)	0.2443	40	NA	0.02 J
Lead, Pb (ug/L)	3.703	15	NA	15.7
Mercury, Hg (ug/L)	1.16	2	NA	0.006
Molybdenum, Mo (ug/L)	62.4	100	NA	3.02
Radium 226 & 228 (combined) (pCi/L)	5.523	8.02	NA	NA
Selenium, Se (ug/L)	1.9	50	NA	1.9
Thallium, Tl (ug/L)	0.25	2	NA	0.5 U

Notes:
NA = Sample not analyzed for the parameter
UTL: Upper Threshold Limit
GWPS: Groundwater Protection Standard

CF-15-07
SUMMARY OF 2018 ANALYTICAL RESULTS
Indiana-Kentucky Electric Corporation
Clifty Creek Station
Madison, Indiana

Parameter	UTL	GWPS	Mar-18	Oct-18	Dec-18
Appendix III Constituents					
Boron, B (mg/L)	5.02	--	0.204	0.112	NA
Calcium, Ca (mg/L)	314.4	--	123	168	NA
Chloride, Cl (mg/L)	282	--	10.6	5.34	NA
Fluoride, F (mg/L)	0.5477	--	0.2	0.24	NA
pH (s.u.)	5.57 - 10.36	--	10.12	7.29	NA
Sulfate, SO4 (mg/L)	634	--	32.7	2.7	NA
Total Dissolved Solids (TDS) (mg/L)	1290	--	548	1240	NA
Appendix IV Constituents					
Antimony, Sb (ug/L)	0.2556	6	NA	0.06 J	NA
Arsenic, As (ug/L)	4.47	10	NA	6.81	2.49
Barium, Ba (ug/L)	129.1	2000	NA	92.4	NA
Beryllium, Be (ug/L)	0.934	4	NA	0.1 U	NA
Cadmium, Cd (ug/L)	0.3	5	NA	0.07	NA
Chromium, Cr (ug/L)	8.4	100	NA	0.36	NA
Cobalt, Co (ug/L)	4.01	6	NA	2.41	NA
Fluoride, F (ug/L)	0.5477	4	0.2	0.24	NA
Lithium, Li (ug/L)	0.2443	40	NA	0.03 U	NA
Lead, Pb (ug/L)	3.703	15	NA	0.336	NA
Mercury, Hg (ug/L)	1.16	2	NA	0.004 J	NA
Molybdenum, Mo (ug/L)	62.4	100	NA	12.8	NA
Radium 226 & 228 (combined) (pCi/L)	5.523	8.02	NA	0.387	NA
Selenium, Se (ug/L)	1.9	50	NA	0.2 J	NA
Thallium, Tl (ug/L)	0.25	2	NA	0.5 U	NA

Notes:
NA = Sample not analyzed for the parameter
UTL: Upper Threshold Limit
GWPS: Groundwater Protection Standard

CF-15-08
SUMMARY OF 2018 ANALYTICAL RESULTS
Indiana-Kentucky Electric Corporation
Clifty Creek Station
Madison, Indiana

Parameter	UTL	GWPS	Mar-18	May-18	Oct-18	Dec-18
Appendix III Constituents						
Boron, B (mg/L)	5.02	--	8.5	8.6	11.9	11.9
Calcium, Ca (mg/L)	314.4	--	123	NA	145	NA
Chloride, Cl (mg/L)	282	--	14.7	NA	17.4	NA
Fluoride, F (mg/L)	0.5477	--	0.41	NA	0.41	NA
pH (s.u.)	5.57 - 10.36	--	10.21	7.45	7.53	NA
Sulfate, SO4 (mg/L)	634	--	203	NA	257	NA
Total Dissolved Solids (TDS) (mg/L)	1290	--	588	NA	636	NA
Appendix IV Constituents						
Antimony, Sb (ug/L)	0.2556	6	NA	NA	0.07 J	NA
Arsenic, As (ug/L)	4.47	10	NA	NA	0.94	NA
Barium, Ba (ug/L)	129.1	2000	NA	NA	51.4	NA
Beryllium, Be (ug/L)	0.934	4	NA	NA	0.1 U	NA
Cadmium, Cd (ug/L)	0.3	5	NA	NA	0.02 J	NA
Chromium, Cr (ug/L)	8.4	100	NA	NA	0.385	NA
Cobalt, Co (ug/L)	4.01	6	NA	NA	0.547	NA
Fluoride, F (ug/L)	0.5477	4	0.41	NA	0.41	NA
Lithium, Li (ug/L)	0.2443	40	NA	NA	0.02 J	NA
Lead, Pb (ug/L)	3.703	15	NA	NA	0.457	NA
Mercury, Hg (ug/L)	1.16	2	NA	NA	0.004 J	NA
Molybdenum, Mo (ug/L)	62.4	100	NA	NA	524	429
Radium 226 & 228 (combined) (pCi/L)	5.523	8.02	NA	NA	0.437	NA
Selenium, Se (ug/L)	1.9	50	NA	NA	0.07 J	NA
Thallium, Tl (ug/L)	0.25	2	NA	NA	0.5 U	NA

Notes:
NA = Sample not analyzed for the parameter
UTL: Upper Threshold Limit
GWPS: Groundwater Protection Standard

CF-15-09
SUMMARY OF 2018 ANALYTICAL RESULTS
Indiana-Kentucky Electric Corporation
Clifty Creek Station
Madison, Indiana

Parameter	UTL	GWPS	Mar-18	May-18	Oct-18	Dec-18
Appendix III Constituents						
Boron, B (mg/L)	5.02	--	5.86	6.1	7.59	7.41
Calcium, Ca (mg/L)	314.4	--	184	NA	250	NA
Chloride, Cl (mg/L)	282	--	3.52	NA	3.47	NA
Fluoride, F (mg/L)	0.5477	--	0.3	NA	0.32	NA
pH (s.u.)	5.57 - 10.36	--	10.85	7.09	7.05	NA
Sulfate, SO4 (mg/L)	634	--	287	NA	274	NA
Total Dissolved Solids (TDS) (mg/L)	1290	--	710	NA	790	NA
Appendix IV Constituents						
Antimony, Sb (ug/L)	0.2556	6	NA	NA	0.16	NA
Arsenic, As (ug/L)	4.47	10	NA	NA	4.67	0.26
Barium, Ba (ug/L)	129.1	2000	NA	NA	38.2	NA
Beryllium, Be (ug/L)	0.934	4	NA	NA	0.261	<0.02
Cadmium, Cd (ug/L)	0.3	5	NA	NA	0.05 J	NA
Chromium, Cr (ug/L)	8.4	100	NA	NA	14.9	0.419
Cobalt, Co (ug/L)	4.01	6	NA	NA	7.45	0.04
Fluoride, F (ug/L)	0.5477	4	0.3	NA	0.32	NA
Lithium, Li (ug/L)	0.2443	40	NA	NA	0.02 J	NA
Lead, Pb (ug/L)	3.703	15	NA	NA	6.25	0.03
Mercury, Hg (ug/L)	1.16	2	NA	NA	0.007	NA
Molybdenum, Mo (ug/L)	62.4	100	NA	NA	85.9	87.1
Radium 226 & 228 (combined) (pCi/L)	5.523	8.02	NA	NA	NA	NA
Selenium, Se (ug/L)	1.9	50	NA	NA	1.3	0.1
Thallium, Tl (ug/L)	0.25	2	NA	NA	0.5 U	NA

Notes:
NA = Sample not analyzed for the parameter
UTL: Upper Threshold Limit
GWPS: Groundwater Protection Standard

WBSP-15-01
SUMMARY OF 2018 ANALYTICAL RESULTS
Indiana-Kentucky Electric Corporation
Clifty Creek Station
Madison, Indiana

Parameter	UTL	GWPS	Mar-18	Oct-18
Appendix III Constituents				
Boron, B (mg/L)	5.02	--	0.1	0.134
Calcium, Ca (mg/L)	314.4	--	157	164
Chloride, Cl (mg/L)	282	--	9.45	25.3
Fluoride, F (mg/L)	0.5477	--	0.27	0.31
pH (s.u.)	5.57 - 10.36	--	6.65	6.37
Sulfate, SO4 (mg/L)	634	--	139	146
Total Dissolved Solids (TDS) (mg/L)	1290	--	685	711
Appendix IV Constituents				
Antimony, Sb (ug/L)	0.2556	6	NA	0.09 J
Arsenic, As (ug/L)	4.47	10	NA	1.52
Barium, Ba (ug/L)	129.1	2000	NA	25.3
Beryllium, Be (ug/L)	0.934	4	NA	0.144
Cadmium, Cd (ug/L)	0.3	5	NA	0.03 J
Chromium, Cr (ug/L)	8.4	100	NA	4.76
Cobalt, Co (ug/L)	4.01	6	NA	2.91
Fluoride, F (ug/L)	0.5477	4	0.27	0.31
Lithium, Li (ug/L)	0.2443	40	NA	0.034
Lead, Pb (ug/L)	3.703	15	NA	2.63
Mercury, Hg (ug/L)	1.16	2	NA	NA
Molybdenum, Mo (ug/L)	62.4	100	NA	0.7 J
Radium 226 & 228 (combined) (pCi/L)	5.523	8.02	NA	NA
Selenium, Se (ug/L)	1.9	50	NA	0.6
Thallium, Tl (ug/L)	0.25	2	NA	0.5 U

Notes:
NA = Sample not analyzed for the parameter
UTL: Upper Threshold Limit
GWPS: Groundwater Protection Standard

WBSP-15-02
SUMMARY OF 2018 ANALYTICAL RESULTS
Indiana-Kentucky Electric Corporation
Clifty Creek Station
Madison, Indiana

Parameter	UTL	GWPS	Mar-18	Oct-18
Appendix III Constituents				
Boron, B (mg/L)	5.02	--	3.98	4.36
Calcium, Ca (mg/L)	314.4	--	231	277
Chloride, Cl (mg/L)	282	--	12.1	11.3
Fluoride, F (mg/L)	0.5477	--	0.37	0.36
pH (s.u.)	5.57 - 10.36	--	7.34	6.64
Sulfate, SO4 (mg/L)	634	--	607	515
Total Dissolved Solids (TDS) (mg/L)	1290	--	1200	1190
Appendix IV Constituents				
Antimony, Sb (ug/L)	0.2556	6	NA	0.14
Arsenic, As (ug/L)	4.47	10	NA	0.44
Barium, Ba (ug/L)	129.1	2000	NA	22.6
Beryllium, Be (ug/L)	0.934	4	NA	0.1 U
Cadmium, Cd (ug/L)	0.3	5	NA	0.03 J
Chromium, Cr (ug/L)	8.4	100	NA	0.788
Cobalt, Co (ug/L)	4.01	6	NA	0.081
Fluoride, F (ug/L)	0.5477	4	0.37	0.36
Lithium, Li (ug/L)	0.2443	40	NA	0.088
Lead, Pb (ug/L)	3.703	15	NA	0.09 J
Mercury, Hg (ug/L)	1.16	2	NA	0.002 J
Molybdenum, Mo (ug/L)	62.4	100	NA	2.45
Radium 226 & 228 (combined) (pCi/L)	5.523	8.02	NA	0.3588
Selenium, Se (ug/L)	1.9	50	NA	0.06 J
Thallium, Tl (ug/L)	0.25	2	NA	0.5 U

Notes:
NA = Sample not analyzed for the parameter
UTL: Upper Threshold Limit
GWPS: Groundwater Protection Standard

APPENDIX C

GRAIN SIZE ANALYSIS LAB REPORTS

Stantec

Summary of Soil Tests

Project Name	IKEC Clifty Creek	Project Number	175534018
Source	CF-19-150-22-33	Lab ID	5
Sample Type	SPT	Date Received	3-18-19
		Date Reported	3-28-19

Test Results

Natural Moisture Content

Test Method: ASTM D 2216

Moisture Content (%): 26.4

Particle Size Analysis

Preparation Method: ASTM D 421

Gradation Method: ASTM D 422

Hydrometer Method: ASTM D 422

Particle Size		%
Sieve Size	(mm)	Passing
	N/A	
	N/A	
	N/A	
1 1/2"	37.5	100.0
3/4"	19	98.6
3/8"	9.5	98.3
No. 4	4.75	97.6
No. 10	2	95.3
No. 40	0.425	93.4
No. 200	0.075	80.6
	0.02	50.6
	0.005	27.9
	0.002	19.5
estimated	0.001	14.9

Plus 3 in. material, not included: 0 (%)

Range	ASTM (%)	AASHTO (%)
Gravel	2.4	4.7
Coarse Sand	2.3	1.9
Medium Sand	1.9	---
Fine Sand	12.8	12.8
Silt	52.7	61.1
Clay	27.9	19.5

Atterberg Limits

Test Method: ASTM D 4318 Method A

Prepared: Dry

Liquid Limit: 35

Plastic Limit: 20

Plasticity Index: 15

Activity Index: 0.8

Moisture-Density Relationship

Test Not Performed

Maximum Dry Density (lb/ft^3): N/A

Maximum Dry Density (kg/m^3): N/A

Optimum Moisture Content (%): N/A

Over Size Correction %: N/A

California Bearing Ratio

Test Not Performed

Bearing Ratio (%): N/A

Compacted Dry Density (lb/ft^3): N/A

Compacted Moisture Content (%): N/A

Specific Gravity

Estimated

Particle Size: No. 10

Specific Gravity at 20° Celsius: 2.70

Classification

Unified Group Symbol: CL

Group Name: Lean clay with sand

AASHTO Classification: A-6 (11)

Comments:

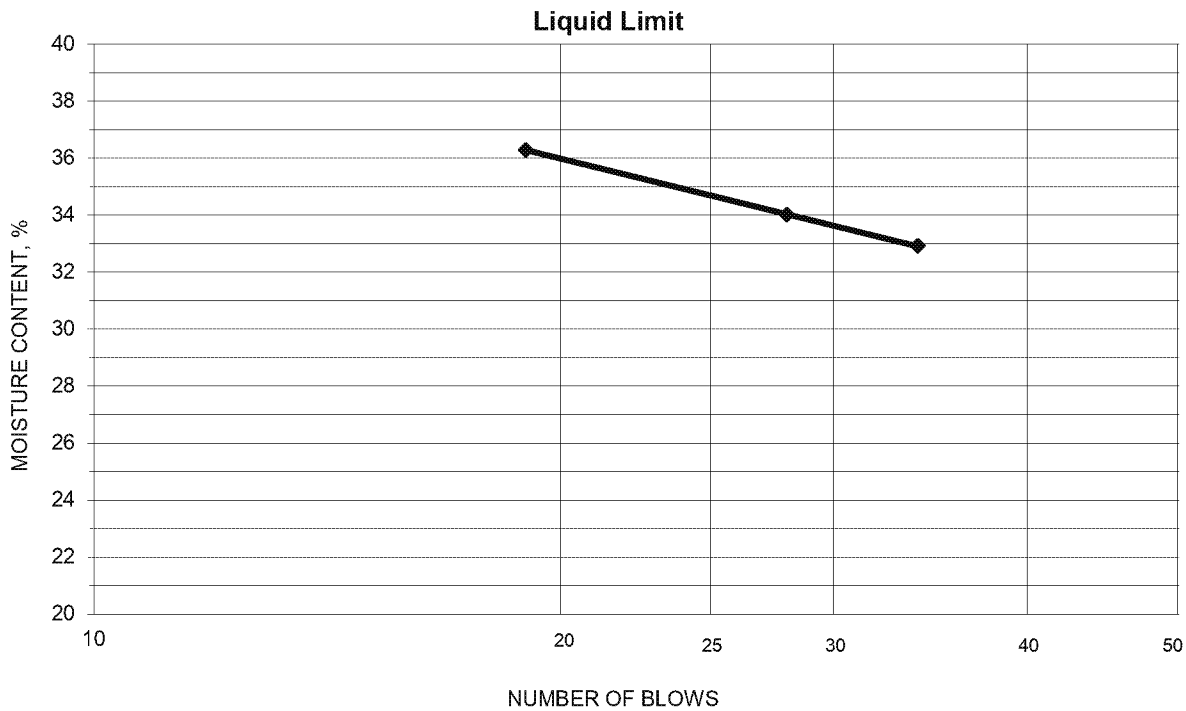
Reviewed By JS

Stantec

ATTERBERG LIMITS

Project	IKEC Clifty Creek	Project No.	175534018
Source	CF-19-150-22-33	Lab ID	5
		% + No. 40	7
Tested By	MP	Test Method	ASTM D 4318 Method A
Date Received	03-18-2019		
Test Date	03-19-2019	Prepared	Dry

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Number of Blows	Water Content (%)	Liquid Limit
23.87	20.70	11.07	34	32.9	
22.90	19.76	10.53	28	34.0	
22.84	19.69	11.01	19	36.3	35



PLASTIC LIMIT AND PLASTICITY INDEX

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Water Content (%)	Plastic Limit	Plasticity Index
18.25	16.96	10.67	20.5	20	15
18.05	16.90	11.09	19.8		

Remarks:

Reviewed By JS

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Approved By: RJ

Stantec Consulting Services Inc.

Particle-Size Analysis of Soils
ASTM D 422

Project Name	IKEC Clifty Creek	Project Number	175534018
Source	CF-19-150-22-33	Lab ID	5

Sieve analysis for the Portion Coarser than the No. 10 Sieve

Test Method: ASTM D 422
Prepared using: ASTM D 421

Particle Shape: Angular
Particle Hardness: Hard and Durable

Tested By: MP
Test Date: 03-18-2019
Date Received: 03-18-2019

Maximum Particle size: 1 1/2" Sieve

Sieve Size	% Passing
1 1/2"	100.0
3/4"	98.6
3/8"	98.3
No. 4	97.6
No. 10	95.3

Analysis for the portion Finer than the No. 10 Sieve

Analysis Based on -3 inch fraction only

Specific Gravity: 2.7

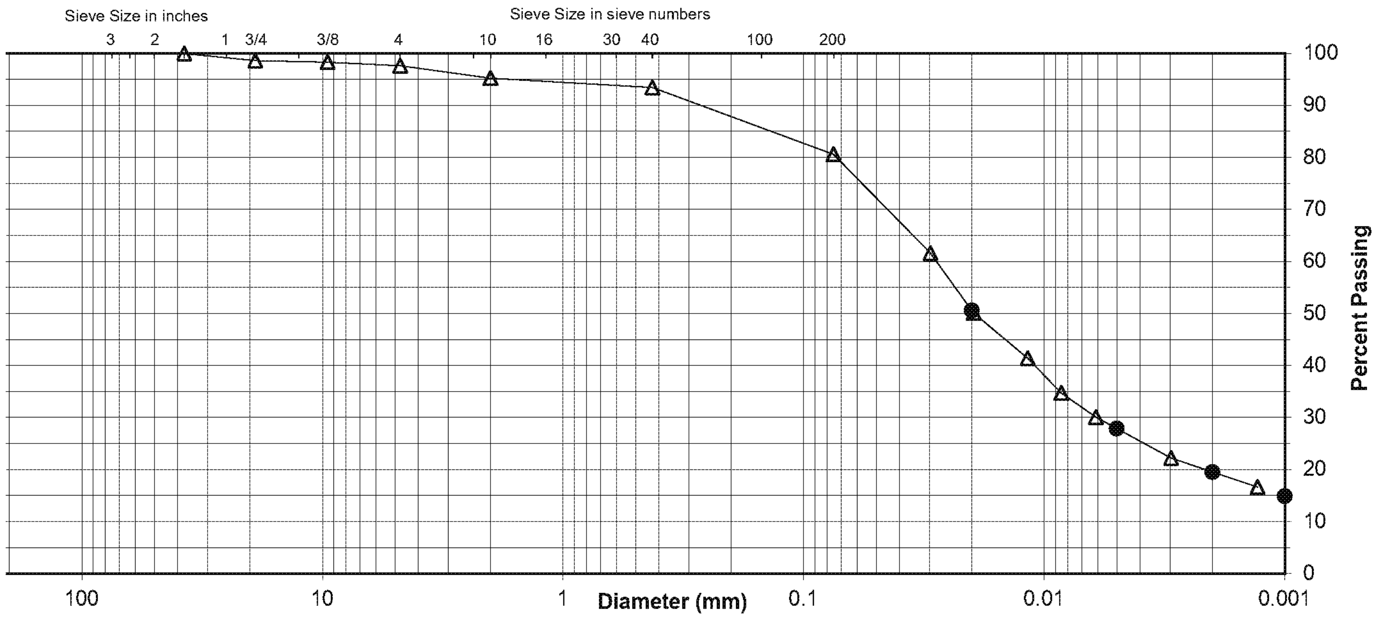
Dispersed using Apparatus A - Mechanical, for 1 minute

Sieve Size	% Passing
No. 40	93.4
No. 200	80.6
0.02 mm	50.6
0.005 mm	27.9
0.002 mm	19.5
0.001 mm	14.9

Particle Size Distribution

	Coarse Gravel	Fine Gravel	C. Sand	Medium Sand	Fine Sand	Silt	Clay
ASTM	1.4	1.0	2.3	1.9	12.8	52.7	27.9

	Gravel	Coarse Sand	Fine Sand	Silt	Clay
AASHTO	4.7	1.9	12.8	61.1	19.5



Comments ______________________

Reviewed By JS

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Version: 20170217
Approved By: RJ

Stantec Consulting Services Inc.

Stantec

Summary of Soil Tests

Project Name	IKEC Clifty Creek	Project Number	175534018
Source	CF-19-150-64-70	Lab ID	6
Sample Type	SPT	Date Received	3-18-19
		Date Reported	3-28-19

Test Results

Natural Moisture Content

Test Method: ASTM D 2216

Moisture Content (%): 17.7

Particle Size Analysis

Preparation Method: ASTM D 421

Gradation Method: ASTM D 422

Hydrometer Method: ASTM D 422

Particle Size		%
Sieve Size	(mm)	Passing
	N/A	
	N/A	
	N/A	
1 1/2"	37.5	100.0
3/4"	19	92.8
3/8"	9.5	84.2
No. 4	4.75	77.2
No. 10	2	69.1
No. 40	0.425	62.1
No. 200	0.075	53.5
	0.02	39.6
	0.005	22.5
	0.002	16.1
estimated	0.001	12.6

Plus 3 in. material, not included: 0 (%)

	ASTM	AASHTO
Range	(%)	(%)
Gravel	22.8	30.9
Coarse Sand	8.1	7.0
Medium Sand	7.0	---
Fine Sand	8.6	8.6
Silt	31.0	37.4
Clay	22.5	16.1

Atterberg Limits

Test Method: ASTM D 4318 Method A

Prepared: Dry

Liquid Limit: 34

Plastic Limit: 20

Plasticity Index: 14

Activity Index: 0.9

Moisture-Density Relationship

Test Not Performed

Maximum Dry Density (lb/ft^3): N/A

Maximum Dry Density (kg/m^3): N/A

Optimum Moisture Content (%): N/A

Over Size Correction %: N/A

California Bearing Ratio

Test Not Performed

Bearing Ratio (%): N/A

Compacted Dry Density (lb/ft^3): N/A

Compacted Moisture Content (%): N/A

Specific Gravity

Estimated

Particle Size: No. 10

Specific Gravity at 20° Celsius: 2.70

Classification

Unified Group Symbol: CL

Group Name: Sandy lean clay with gravel

AASHTO Classification: A-6 (5)

Comments:

Reviewed By JS

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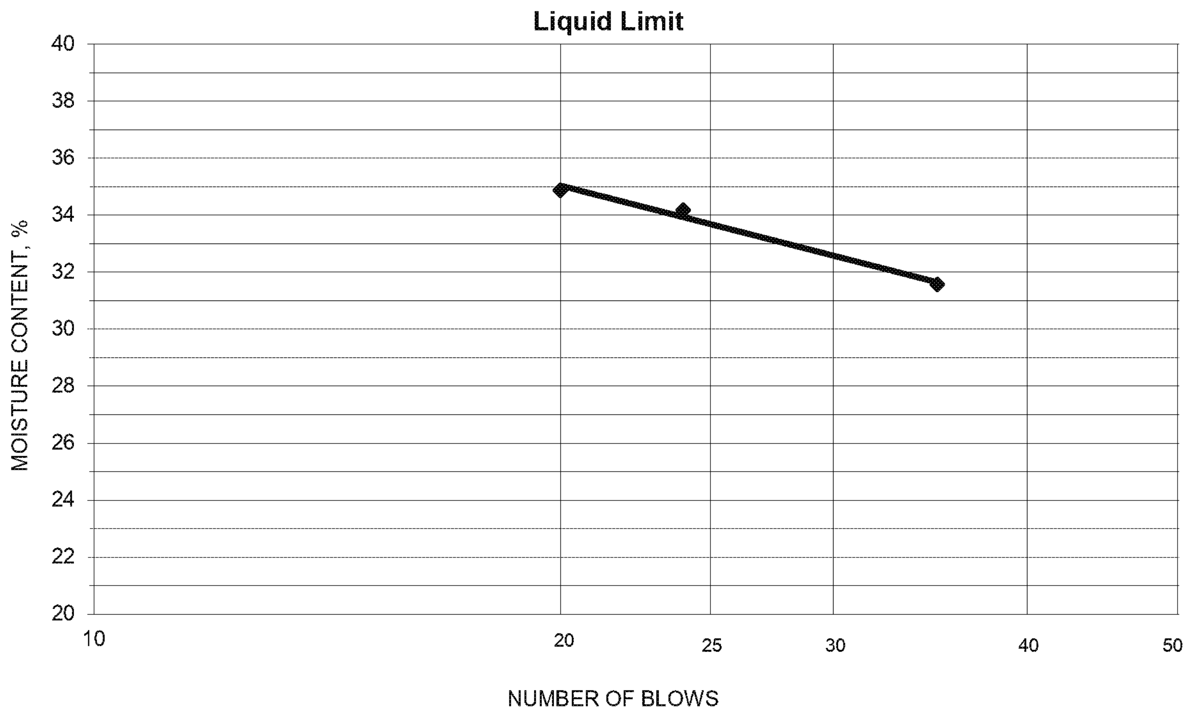
Version: 20170217
Approved By: RJ

Stantec

ATTERBERG LIMITS

Project	IKEC Clifty Creek	Project No.	175534018
Source	CF-19-150-64-70	Lab ID	6
		% + No. 40	38
Tested By	MP	Test Method	ASTM D 4318 Method A
Date Received	03-18-2019		
Test Date	03-19-2019	Prepared	Dry

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Number of Blows	Water Content (%)	Liquid Limit
27.17	23.17	10.50	35	31.6	34
24.96	21.30	10.59	24	34.2	
24.74	21.20	11.05	20	34.9	



PLASTIC LIMIT AND PLASTICITY INDEX

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Water Content (%)	Plastic Limit	Plasticity Index
18.45	17.25	11.05	19.4	20	14
18.47	17.25	11.07	19.7		

Remarks: ____________________

Reviewed By JS

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Version: 20170217
Approved By: RJ

Stantec Consulting Services Inc.

Stantec

Particle-Size Analysis of Soils
ASTM D 422

Project Name	IKEC Clifty Creek	Project Number	175534018
Source	CF-19-150-64-70	Lab ID	6

Sieve analysis for the Portion Coarser than the No. 10 Sieve

Test Method: ASTM D 422
Prepared using: ASTM D 421

Particle Shape: Angular
Particle Hardness: Hard and Durable

Tested By: GW
Test Date: 03-18-2019
Date Received: 03-18-2019

Maximum Particle size: 1 1/2" Sieve

Sieve Size	% Passing
1 1/2"	100.0
3/4"	92.8
3/8"	84.2
No. 4	77.2
No. 10	69.1

Analysis for the portion Finer than the No. 10 Sieve

Analysis Based on -3 inch fraction only

Specific Gravity: 2.7

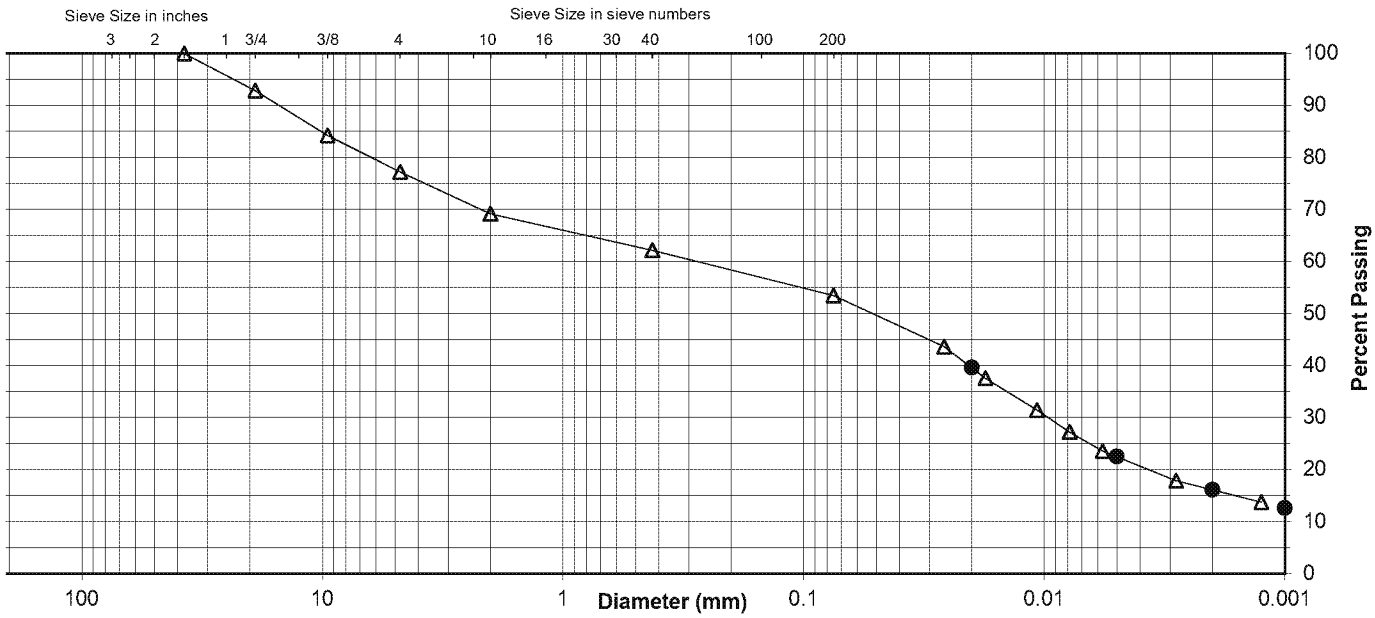
Dispersed using Apparatus A - Mechanical, for 1 minute

Sieve Size	% Passing
No. 40	62.1
No. 200	53.5
0.02 mm	39.6
0.005 mm	22.5
0.002 mm	16.1
0.001 mm	12.6

Particle Size Distribution

ASTM	Coarse Gravel	Fine Gravel	C. Sand	Medium Sand	Fine Sand	Silt	Clay
	7.2	15.6	8.1	7.0	8.6	31.0	22.5

AASHTO	Gravel	Coarse Sand	Fine Sand	Silt	Clay
	30.9	7.0	8.6	37.4	16.1



Comments ______

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Approved By: RJ

Stantec Consulting Services Inc.

Stantec

Summary of Soil Tests

Project Name	IKEC Clifty Creek	Project Number	175534018
Source	CF-19-80-30-40	Lab ID	7
Sample Type	SPT	Date Received	3-18-19
		Date Reported	3-28-19

Test Results

Natural Moisture Content

Test Method: ASTM D 2216

Moisture Content (%): 18.2

Particle Size Analysis

Preparation Method: ASTM D 421

Gradation Method: ASTM D 422

Hydrometer Method: ASTM D 422

Particle Size		%
Sieve Size	(mm)	Passing
	N/A	
	N/A	
	N/A	
	N/A	
	N/A	
3/8"	9.5	100.0
No. 4	4.75	99.6
No. 10	2	97.7
No. 40	0.425	88.4
No. 200	0.075	21.0
	0.02	8.6
	0.005	3.4
	0.002	2.0
estimated	0.001	1.1

Plus 3 in. material, not included: 0 (%)

Range	ASTM (%)	AASHTO (%)
Gravel	0.4	2.3
Coarse Sand	1.9	9.3
Medium Sand	9.3	---
Fine Sand	67.4	67.4
Silt	17.6	19.0
Clay	3.4	2.0

Atterberg Limits

Test Method: ASTM D 4318 Method A

Prepared: Dry

Liquid Limit: NP

Plastic Limit: NP

Plasticity Index: NP

Activity Index: N/A

Moisture-Density Relationship

Test Not Performed

Maximum Dry Density (lb/ft^3): N/A

Maximum Dry Density (kg/m^3): N/A

Optimum Moisture Content (%): N/A

Over Size Correction %: N/A

California Bearing Ratio

Test Not Performed

Bearing Ratio (%): N/A

Compacted Dry Density (lb/ft^3): N/A

Compacted Moisture Content (%): N/A

Specific Gravity

Estimated

Particle Size: No. 10

Specific Gravity at 20° Celsius: 2.70

Classification

Unified Group Symbol: SM

Group Name: Silty sand

AASHTO Classification: A-2-4 (0)

Comments:

Reviewed By JS

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Version: 20170217
Approved By: RJ

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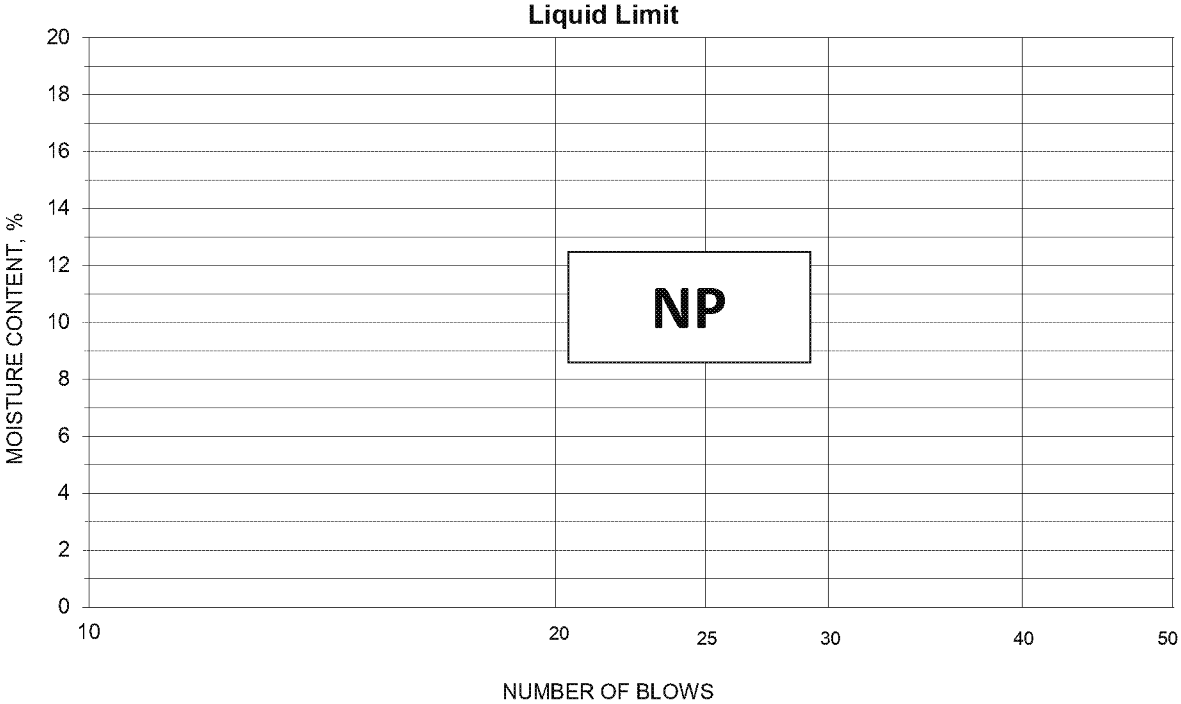
ATTERBERG LIMITS

Project	IKEC Clifty Creek	Project No.	175534018
Source	CF-19-80-30-40	Lab ID	7
		% + No. 40	12
Tested By	MP	Date Received	03-18-2019
Test Method	ASTM D 4318 Method A		
Test Date	03-19-2019		
Prepared	Dry		

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Number of Blows	Water Content (%)	Liquid Limit

Liquid Limit



PLASTIC LIMIT AND PLASTICITY INDEX

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Water Content (%)	Plastic Limit	Plasticity Index

Remarks:

Reviewed By JS

Particle-Size Analysis of Soils
ASTM D 422

Project Name IKEC Clifty Creek
Source CF-19-80-30-40

Project Number 175534018
Lab ID 7

Sieve analysis for the Portion Coarser than the No. 10 Sieve

Test Method ASTM D 422
Prepared using ASTM D 421

Particle Shape Angular
Particle Hardness: Hard and Durable

Tested By GW
Test Date 03-18-2019
Date Received 03-18-2019

Maximum Particle size: 3/8" Sieve

Sieve Size	% Passing
3/8"	100.0
No. 4	99.6
No. 10	97.7

Analysis for the portion Finer than the No. 10 Sieve

Analysis Based on -3 inch fraction only

Specific Gravity 2.7

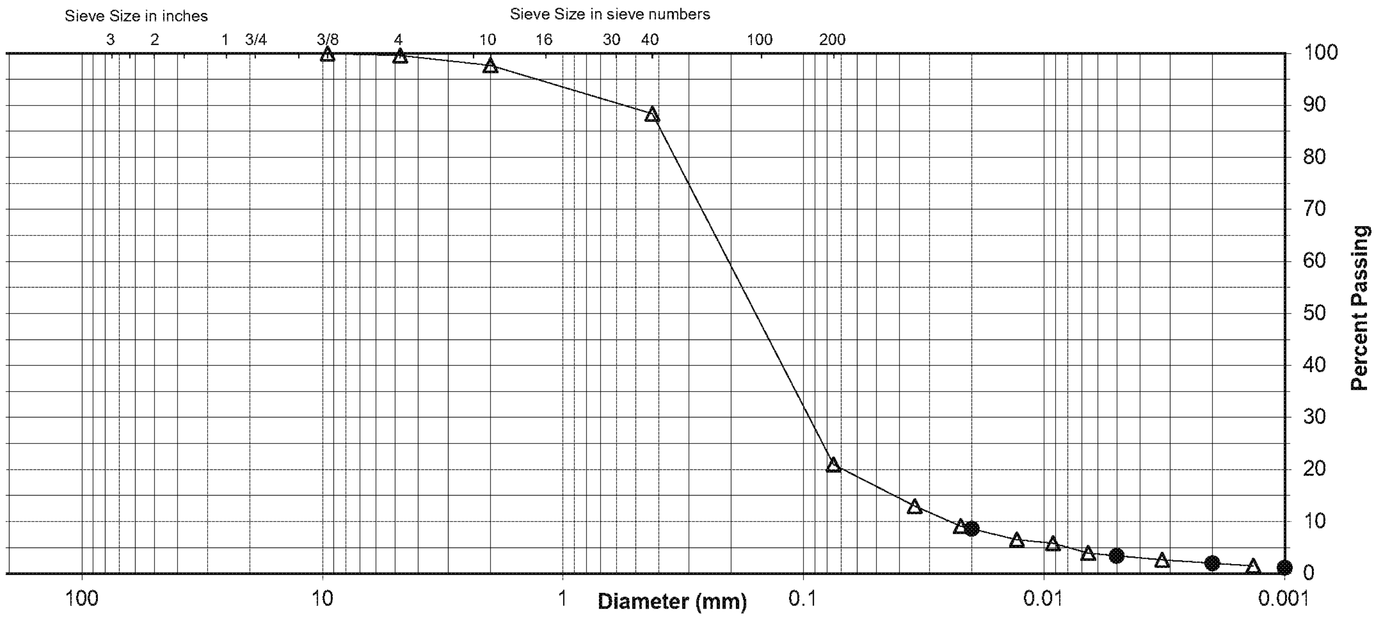
Dispersed using Apparatus A - Mechanical, for 1 minute

No. 40	88.4
No. 200	21.0
0.02 mm	8.6
0.005 mm	3.4
0.002 mm	2.0
0.001 mm	1.1

Particle Size Distribution

	Coarse Gravel	Fine Gravel	C. Sand	Medium Sand	Fine Sand	Silt	Clay
ASTM	0.0	0.4	1.9	9.3	67.4	17.6	3.4

	Gravel	Coarse Sand	Fine Sand	Silt	Clay
AASHTO	2.3	9.3	67.4	19.0	2.0



Comments

Reviewed By JS

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Stantec

Summary of Soil Tests

Project Name	IKEC Clifty Creek	Project Number	175534018
Source	CF-19-80-84-89	Lab ID	8
Sample Type	SPT	Date Received	3-18-19
		Date Reported	3-28-19

Test Results

Natural Moisture Content

Test Method: ASTM D 2216

Moisture Content (%): 10.5

Particle Size Analysis

Preparation Method: ASTM D 421

Gradation Method: ASTM D 422

Hydrometer Method: ASTM D 422

Particle Size		%
Sieve Size	(mm)	Passing
	N/A	
	N/A	
	N/A	
1 1/2"	37.5	100.0
3/4"	19	78.9
3/8"	9.5	61.7
No. 4	4.75	50.7
No. 10	2	41.1
No. 40	0.425	34.5
No. 200	0.075	28.0
	0.02	18.8
	0.005	9.4
	0.002	6.4
estimated	0.001	4.8

Plus 3 in. material, not included: 0 (%)

Range	ASTM (%)	AASHTO (%)
Gravel	49.3	58.9
Coarse Sand	9.6	6.6
Medium Sand	6.6	---
Fine Sand	6.5	6.5
Silt	18.6	21.6
Clay	9.4	6.4

Atterberg Limits

Test Method: ASTM D 4318 Method A

Prepared: Dry

Liquid Limit: 27

Plastic Limit: 16

Plasticity Index: 11

Activity Index: 1.7

Moisture-Density Relationship

Test Not Performed

Maximum Dry Density (lb/ft^3): N/A

Maximum Dry Density (kg/m^3): N/A

Optimum Moisture Content (%): N/A

Over Size Correction %: N/A

California Bearing Ratio

Test Not Performed

Bearing Ratio (%): N/A

Compacted Dry Density (lb/ft^3): N/A

Compacted Moisture Content (%): N/A

Specific Gravity

Estimated

Particle Size: No. 10

Specific Gravity at 20° Celsius: 2.70

Classification

Unified Group Symbol: GC

Group Name: Clayey gravel with sand

AASHTO Classification: A-2-6 (0)

Comments:

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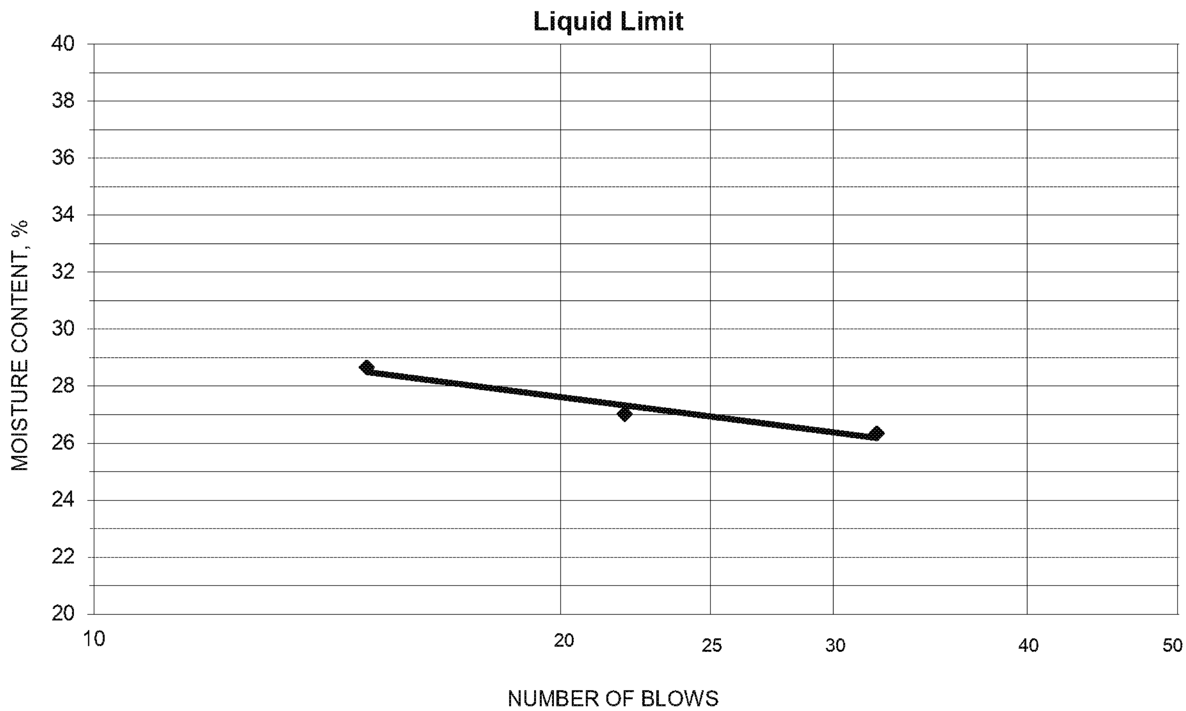
ATTERBERG LIMITS

Project	IKEC Clifty Creek	Project No.	175534018
Source	CF-19-80-84-89	Lab ID	8
		% + No. 40	65
Tested By	MP	Test Method	ASTM D 4318 Method A
Date Received	03-18-2019		
Test Date	03-19-2019	Prepared	Dry

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Number of Blows	Water Content (%)	Liquid Limit
22.33	19.98	11.06	32	26.3	27
22.20	19.82	11.01	22	27.0	
21.89	19.46	10.98	15	28.7	



PLASTIC LIMIT AND PLASTICITY INDEX

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Water Content (%)	Plastic Limit	Plasticity Index
17.57	16.65	11.10	16.6	16	11
17.04	16.20	11.02	16.2		

Remarks: ______

Reviewed By JS

Template: tmp_sum_input.xlsm
Version: 20170217
Approved By: RJ

Stantec Consulting Services Inc.

Particle-Size Analysis of Soils
ASTM D 422

Project Name: IKEC Clifty Creek
Source: CF-19-80-84-89

Project Number: 175534018
Lab ID: 8

Sieve analysis for the Portion Coarser than the No. 10 Sieve

Test Method: ASTM D 422
Prepared using: ASTM D 421

Particle Shape: Angular
Particle Hardness: Hard and Durable

Tested By: GW
Test Date: 03-18-2019
Date Received: 03-18-2019

Maximum Particle size: 1 1/2" Sieve

Sieve Size	% Passing
1 1/2"	100.0
3/4"	78.9
3/8"	61.7
No. 4	50.7
No. 10	41.1

Analysis for the portion Finer than the No. 10 Sieve

Analysis Based on -3 inch fraction only

Specific Gravity: 2.7

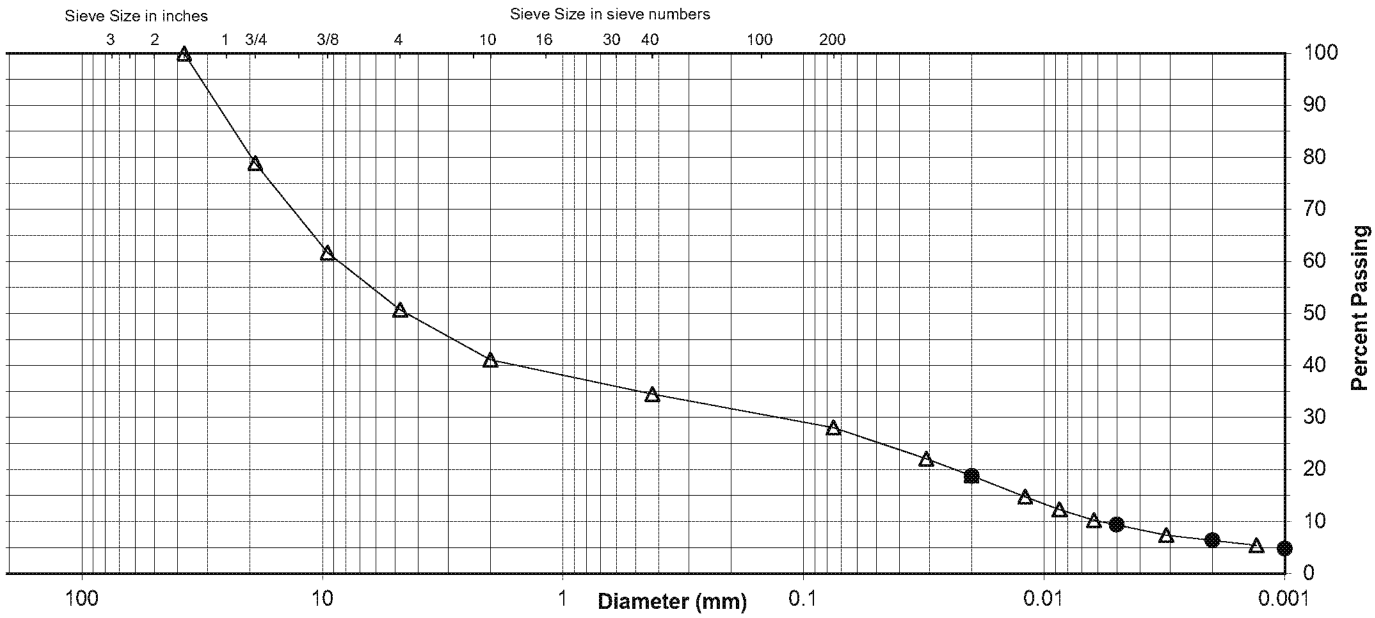
Dispersed using Apparatus A - Mechanical, for 1 minute

No. 40	34.5
No. 200	28.0
0.02 mm	18.8
0.005 mm	9.4
0.002 mm	6.4
0.001 mm	4.8

Particle Size Distribution

ASTM	Coarse Gravel	Fine Gravel	C. Sand	Medium Sand	Fine Sand	Silt	Clay
	21.1	28.2	9.6	6.6	6.5	18.6	9.4

AASHTO	Gravel	Coarse Sand	Fine Sand	Silt	Clay
	58.9	6.6	6.5	21.6	6.4



Comments ______________________

Reviewed By JS

APPENDIX D

WELL BORING AND CONSTRUCTION LOGS

BORING NO. CF-19-08D
SAMPLE/CORE LOG

Project Number:	2019042	Log Page	1 of 2
Project Location:	Clifty Creek Plant LRCP	Drilling Contractor:	Bowser Morner
Drilling Date(s):	3/5/2019-3/6/2019	Geologist:	Michael Gelles

Drilling Method:	Hollow Stem Auger	Coring Device Size:	NA	Hammer Wt.	160lb and Drop 2ft
Sampling Method:	Split Spoon	Borehole Diameter:	6”	Drilling Fluid Used:	Water
Sampling Interval:	2’	Borehole Depth:	89’	Surface Elevation:	460.68’ MSL

NOTES/COMMENTS:

Depth Interval (feet)	Sample Recovery (feet)	Penetration (Hyd. Pres. or Blow Counts)	Sample/Core Description	PID (PPM)
0-2	1.5	3-2-2-3	Orange brown sandy clay, moist	N/A
2-4	1.5	2-3-2-2	Orange brown sandy clay, moist	N/A
4-6	2	2-2-3-3	Orange brown sandy clay, moist	N/A
6-8	1.5	2-3-3-4	Orange brown sandy clay, moist	N/A
8-10	2	5-4-4-4	Orange brown sandy clay, moist	N/A
10-12	2	4-5-5-6	Orange brown sandy clay, moist	N/A
12-14	2	5-5-6-8	Orange brown sandy clay, moist	N/A
14-16	1.5	6-7-6-8	Orange brown sandy clay, wet; water at14 feet	N/A
16-18	1.5	4-4-8-8	Orange brown sandy clay, wet	N/A
18-20	1.5	6-6-7-8	Orange brown sandy clay, wet	N/A
20-22	2	5-5-5-7	Orange brown silty clay, fine sand, wet	N/A
22-24	2	3-2-3-4	Orange brown silty clay, fine sand, wet	N/A
24-26	2	2-4-6-7	Orange brown silty clay, fine sand, wet	N/A
26-28	2	6-7-7-18	26-27 orange brown silty clay, fine sand, wet; 27-28 orange brown till clay, very stiff, plastic, moist	N/A
28-30	2	3-3-8-8	Orange brown silty clay, fine sand, wet	N/A
30-32	2	7-8-11-16	Orange brown fine sand, some silt, wet	N/A
32-34	2	6-7-11-13	Orange brown fine sand, some silt, wet	N/A
34-36	2	6-6-8-10	Orange brown fine sand, some silt, wet	N/A

Project No: 2019042 Geologist: Michael Gelles

36-38	2	6-8-6-10	Orange brown fine sand, some silt, wet	N/A
38-40	2	14-11-6-18	Orange brown fine sand, some silt, wet	N/A
40-42	2	6-8-9-11	Orange brown fine sand, some silt, wet	N/A
42-44	2	4-3-3-5	Orange brown fine sand, some silt, wet	N/A
44-46	1	2-3-4-7	Gray clay, lean, moist	N/A
46-48	1	6-7-8-4	Gray clay, lean, moist	N/A
48-50	0.6	4-5-6-4	Gray clay, lean, moist	N/A
50-52	1	3-4-5-6	Gray clay, lean, moist	N/A
52-54	1	2-3-4-3	Gray clay, lean, moist	N/A
54-56	1.5	3-3-3-3	Gray clay, lean, moist	N/A
56-58	2	2-4-6-6	Gray clay, lean, moist	N/A
58-60	2	3-5-8-8	Gray clay, lean, moist	N/A
60-62	2	5-6-7-8	Gray clay, lean, moist	N/A
62-64	1	1-1-1-1	Gray clay, lean, moist	N/A
64-66	1	1-1-1-2	Gray clay, lean, moist	N/A
66-68	2	4-6-7-6	Gray clay, lean, moist	N/A
68-70	2	5-4-5-9	Gray clay, lean, moist	N/A
70-72	2	5-7-9-9	Gray clay, lean, some silt and sand, moist	N/A
72-74	2	4-5-8-9	Gray clay, lean, some silt and sand, moist	N/A
74-76	2	7-6-7-8	Gray clay, lean, some silt and sand, moist	N/A
76-78	2	5-6-8-9	Gray clay, lean, some silt and sand, moist	N/A
78-80	2	8-4-8-6	Gray clay, lean, some silt and sand, trace gravel, moist	N/A
80-82	1.5	7-8-9-5	Gray clay, lean, some silt and sand, trace gravel, moist	N/A
82-84	2	3-4-4-4	Gray clay, lean, some silt, trace sand, moist	N/A
84-86	0.8	13-15-15-22	Orange brown silty clay, gravel, wet	N/A
86-88	1.2	10-12-15-20	Orange brown silty clay, gravel, wet	N/A
88-89	0.75	8-100/2	88-88.5 orange brown silty clay, gravel, wet; 88.5-88.75 refusal gray limestone	N/A

WELL CONSTRUCTION LOG
WELL NO. CF-19-08D

Project Number:	2019042
Project Location:	Clifty Creek Plant – LRCP
Installation Date(s):	3/5/2019-3/8/2019
Drilling Method:	Hollow Stem Auger
Drilling Contractor:	Bowser Morner
Development Date(s):	3/14/2019-3/20/2019
Development Method:	Submersible Pump and Bladder Pump

Field parameters stabilized.

Volume Purged:	52 gallons
Static Water-Level*	20.71’
Top of Well Casing Elevation:	463.49’

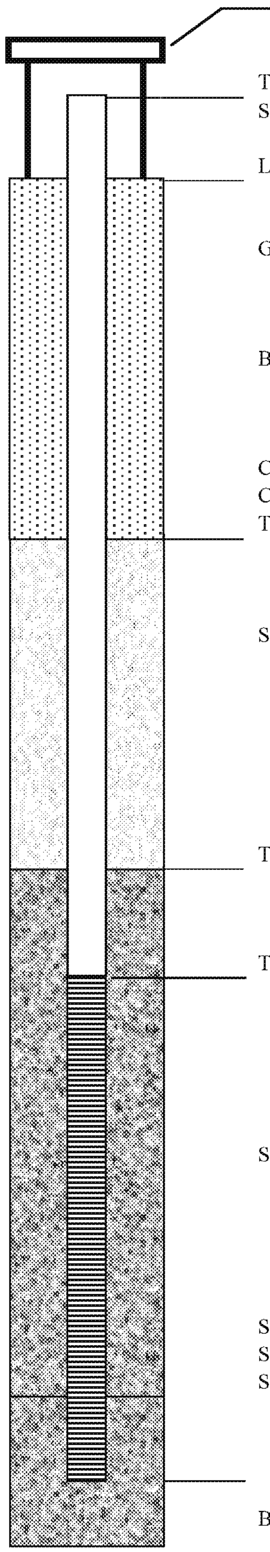
Well Purpose:
Groundwater Monitoring
Northing (Y): 443224.617
Easting (X): 562551.033

Comments/Notes:
2 inch PVC riser and screen
5 ft of 0.010 pre-packed well screen with an inner filter pack of 0.40 mm clean quartz sand and an outer layer of food-grade nylon mesh.

Inspector: Michael Gelles

CONSTRUCTION MATERIALS USED:

3.5	Bags of Sand
1	Bags/Buckets Bentonite Pellets
10	Bags Portland for Grout
	Bags Concrete/Sakrete



Protective Casing with Locking Cap

Top of Casing Elevation: 463.49 ft.
Stick-up: 2.81 ft.

Land Surface Elevation: 460.68 ft.

Grout; Type: Portland cement/ Grout

Borehole Diameter: 6 inch

Casing Diameter: 2 Inch
Casing Material: PVC
Top of Seal: 81 ft*

Seal Type: Bentonite Pellets/Chips

Top of Sand/Gravel Pack: 83 ft*

Top of Well Screen 84 ft*

Sand/Gravel Pack; Type: Global #5

Screen Diameter: 2 Inch
Screen Slot-Size: 0.010 Inch
Screen Material: PVC

Bottom of Well Screen 89 ft.*

Base of Borehole: 89 ft.*

Total Depth of Well Below Top of Casing: 91.81 ft.

*Indicates Depth Below Land Surface

BORING NO. CF-19-14
SAMPLE/CORE LOG

Project Number:	2019042	Log Page	1 of 1
Project Location:	Clifty Creek Plant LRCP	Drilling Contractor:	Bowser Morner
Drilling Date(s):	3/7/2019	Geologist:	Michael Gelles

Drilling Method:	Hollow Stem Auger	Coring Device Size:	NA	Hammer Wt.	160lb	and Drop	2ft
Sampling Method:	Split Spoon	Borehole Diameter:	6”	Drilling Fluid Used:	Water		
Sampling Interval:	2’	Borehole Depth:	20’	Surface Elevation:	452.29’ msl		

NOTES/COMMENTS:

Depth Interval (feet)	Sample Recovery (feet)	Penetration (Hyd. Pres. or Blow Counts)	Sample/Core Description	PID (PPM)
0-2	1.5	1-2-2-2	Brown silty clay, moist	N/A
2-4	1.5	3-3-6-7	Brown silty clay, moist	N/A
4-6	2	3-4-6-7	Brown silty clay, moist	N/A
6-8	2	7-8-6-7	Orange brown silty clay, moist	N/A
8-10	2	4-6-5-6	Orange brown silty clay, moist	N/A
10-12	2	2-3-4-3	Orange brown silty clay, moist	N/A
12-14	1.5	2-2-3-4	Orange brown silty clay, moist	N/A
14-16	2	3-2-2-3	Orange brown silty clay, wet, water at 14 feet	N/A
16-18	2	3-2-2-3	Orange brown silty clay, wet	N/A
18-20	1.5	6-1-3-100/4	Orange brown silty clay, wet; refusal gray limestone	N/A

WELL CONSTRUCTION LOG
WELL NO. CF-19-14

Project Number: 2019042

Project Location: Clifty Creek Plant – LRCP

Installation Date(s): 3/7/2019-3/8/2019

Drilling Method: Hollow Stem Auger
Drilling Contractor: Bowser Morner

Development Date(s): 3/14/2019-3/20/2019

Development Method: Submersible Pump and Bladder Pump
Field parameters stabilized.

Volume Purged: 16.5 gallons

Static Water-Level*: 7.09'

Top of Well Casing Elevation: 454.88'

Well Purpose:
Groundwater Monitoring
Northing (Y): 443401.75
Easting (X): 562901.929

Comments/Notes:
2 inch PVC riser and screen
10 ft of 0.010 pre-packed well screen with an inner filter pack of 0.40 mm clean quartz sand and an outer layer of food-grade nylon mesh.

Inspector: Michael Gelles

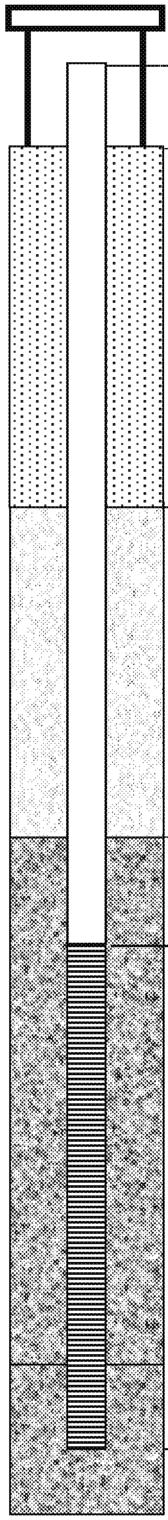
CONSTRUCTION MATERIALS USED:

6.5 Bags of Sand

1 Bags/Buckets Bentonite Pellets

2 Bags Portland for Grout

Bags Concrete/Sakrete



Protective Casing with Locking Cap

Top of Casing Elevation: 454.88 ft.
Stick-up: 2.59 ft.

Land Surface Elevation: 452.29 ft.

Grout; Type: Portland cement/ Grout

Borehole Diameter: 6 inch

Casing Diameter: 2 Inch
Casing Material: PVC
Top of Seal: 7 ft*

Seal Type: Bentonite Pellets/Chips

Top of Sand/Gravel Pack: 9 ft*

Top of Well Screen 10 ft*

Sand/Gravel Pack; Type: Global #5

Screen Diameter: 2 Inch
Screen Slot-Size: 0.010 Inch
Screen Material: PVC

Bottom of Well Screen 20 ft.*

Base of Borehole: 20 ft.*

Total Depth of Well Below Top of Casing: 22.59 ft.

*Indicates Depth Below Land Surface

BORING NO. CF-19-15
SAMPLE/CORE LOG

Project Number:	2019042	Log Page	1 of 1
Project Location:	Clifty Creek Plant LRCP	Drilling Contractor:	Bowser Morner
Drilling Date(s):		Geologist:	Michael Gelles

Drilling Method:	Hollow Stem Auger	Coring Device Size:	NA	Hammer Wt.	160lb and Drop 2ft
Sampling Method:	Split Spoon	Borehole Diameter:	6”	Drilling Fluid Used:	Water
Sampling Interval:	2’	Borehole Depth:	33’	Surface Elevation:	441.10’ msl

NOTES/COMMENTS:

Depth Interval (feet)	Sample Recovery (feet)	Penetration (Hyd. Pres. or Blow Counts)	Sample/Core Description	PID (PPM)
0-33	NA	NA	Advanced augers – no samples (see CF-19-15D log)	N/A

WELL CONSTRUCTION LOG
WELL NO. CF-19-15

Project Number: 2019042

Project Location: Clifty Creek Plant – LRCP

Installation Date(s): 3/13/2019

Drilling Method: Hollow Stem Auger
Drilling Contractor: Bowser Morner

Development Date(s): 3/14/2019-3/21/2019

Development Method: Submersible Pump and Bladder Pump
Field parameters stabilized.

Volume Purged: 24 gallons

Static Water-Level*: 9.90'

Top of Well Casing Elevation: 443.61'

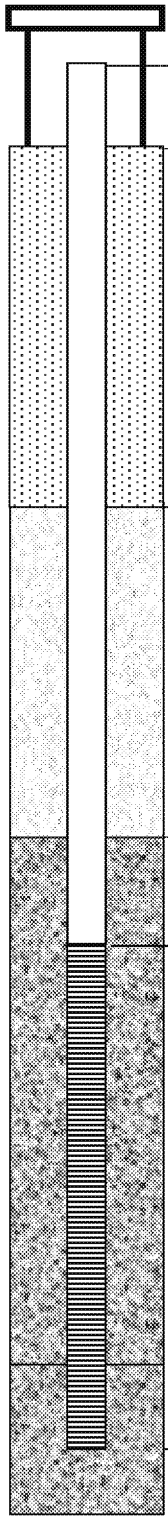
Well Purpose:
Groundwater Monitoring
Northing (Y): 442704.784
Easting (X): 562483.023

Comments/Notes:
2 inch PVC riser and screen
10 ft of 0.010 pre-packed well screen with an inner filter pack of 0.40 mm clean quartz sand and an outer layer of food-grade nylon mesh.

Inspector: Michael Gelles

CONSTRUCTION MATERIALS USED:

6	Bags of Sand
1	Bags/Buckets Bentonite Pellets
3	Bags Portland for Grout
	Bags Concrete/Sakrete



Protective Casing with Locking Cap

Top of Casing Elevation: 443.61 ft.
Stick-up: 2.51 ft.

Land Surface Elevation: 441.10 ft.

Grout; Type: Portland cement/ Grout

Borehole Diameter: 6 inch

Casing Diameter: 2 Inch
Casing Material: PVC
Top of Seal: 20 ft*

Seal Type: Bentonite Pellets

Top of Sand/Gravel Pack: 22 ft*

Top of Well Screen 23 ft*

Sand/Gravel Pack; Type: Global #5

Screen Diameter: 2 Inch
Screen Slot-Size: 0.010 Inch
Screen Material: PVC

Bottom of Well Screen 33 ft.*

Base of Borehole: 33 ft.*

Total Depth of Well Below Top of Casing: 35.51 ft.

*Indicates Depth Below Land Surface

BORING NO. CF-19-15D
SAMPLE/CORE LOG

Project Number:	2019042	Log Page	1 of 2
Project Location:	Clifty Creek Plant LRCP	Drilling Contractor:	Bowser Morner
Drilling Date(s):	3/11/2019-3/12/2019	Geologist:	Michael Gelles

Drilling Method:	Hollow Stem Auger	Coring Device Size:	NA	Hammer Wt.	160lb	and Drop	2ft
Sampling Method:	Split Spoon	Borehole Diameter:	6”	Drilling Fluid Used:	Water		
Sampling Interval:	2’	Borehole Depth:	72’	Surface Elevation:	441.78’ MSL		

NOTES/COMMENTS:

Depth Interval (feet)	Sample Recovery (feet)	Penetration (Hyd. Pres. or Blow Counts)	Sample/Core Description	PID (PPM)
0-2	1.5	1-1-3-3	Brown silty clay, sand, moist	N/A
2-4	1.5	2-2-3-3	Brown silty clay, sand, moist	N/A
4-6	1.5	1-2-4-5	Brown silty clay, sand, moist	N/A
6-8	1.5	1-3-4-5	Brown silty clay, sand, moist	N/A
8-10	2	4-4-6-8	Brown silty clay, sand, moist	N/A
10-12	2	4-3-5-7	Brown silty clay, sand, moist	N/A
12-14	2	2-3-5-7	Orange brown silty clay, sand, moist	N/A
14-16	2	3-4-5-5	Orange brown silty clay, sand, moist	N/A
16-18	2	4-5-5-6	Orange brown silty clay, sand, moist	N/A
18-20	2	2-4-5-6	Orange brown silty clay, sand, moist	N/A
20-22	2	2-3-3-5	Orange brown silty clay, sand, moist	N/A
22-24	2	2-3-4-5	Gray silty clay, sand, moist	N/A
24-26	2	2-2-3-4	Gray silty clay, sand, moist	N/A
26-28	2	2-3-3-4	Orange brown silty clay, sand, gravel, wet	N/A
28-30	2	1-2-3-5	Orange brown silty clay, sand, gravel, wet	N/A
30-32	2	3-4-7-8	Orange brown silty clay, sand, gravel, wet	N/A
32-34	2	3-2-6-4	32-33 orange brown silty clay, sand, gravel, wet; 33-34 gray clay, lean, moist	N/A
34-36	2	4-4-4-5	Gray clay, lean, moist	N/A

Project No: 2019042 Geologist: Michael Gelles

36-38	2	4-5-4-5	Gray clay, lean, moist	N/A
38-40	0.5	4-4-4-5	Gray clay, lean, moist	N/A
40-42	2	3-4-6-7	Gray clay, lean, moist	N/A
42-44	2	3-4-6-8	Gray clay, lean, moist	N/A
44-46	2	3-3-5-6	Gray clay, lean, moist	N/A
46-48	2	6-6-7-8	Gray clay, lean, moist	N/A
48-50	2	6-5-7-8	Gray clay, lean, moist	N/A
50-52	2	3-4-4-5	Gray clay, lean, moist	N/A
52-54	2	8-7-5-5	Gray clay, lean, moist	N/A
54-56	2	2-2-2-4	Gray clay, lean, moist	N/A
56-58	2	3-3-4-5	Gray clay, lean, moist	N/A
58-60	2	4-6-7-8	Gray clay, lean, moist	N/A
60-62	1.5	8-7-7-7	Gray clay, lean, moist	N/A
62-64	2	7-5-7-9	Gray clay, lean, moist	N/A
64-66	2	9-7-8-7	Gray silty clay, gravel, sand, wet; water at 64 feet	N/A
66-68	2	9-10-8-15	Gray silty clay, gravel, sand, wet	N/A
68-70	1	12-15-18-50	Gray silty clay, gravel, sand, wet	N/A
70-72	0.1	100/2	Refusal gray limestone	N/A

WELL CONSTRUCTION LOG
WELL NO. CF-19-15D

Project Number: 2019042

Project Location: Clifty Creek Plant – LRCP

Installation Date(s): 3/11/2019-3/12/2019

Drilling Method: Hollow Stem Auger
Drilling Contractor: Bowser Morner

Development Date(s): 3/14/2019-3/21/2019

Development Method: Submersible Pump and Bladder Pump
Field parameters stabilized.

Volume Purged: 48 gallons

Static Water-Level* 15.51'

Top of Well Casing Elevation: 444.34'

Well Purpose:
Groundwater Monitoring
Northing (Y): 442713.897
Easting (X): 562487.596

Comments/Notes:
2 inch PVC riser and screen
5 ft of 0.010 pre-packed well screen with an inner filter pack of 0.40 mm clean quartz sand and an outer layer of food-grade nylon mesh.

Inspector: Michael Gelles

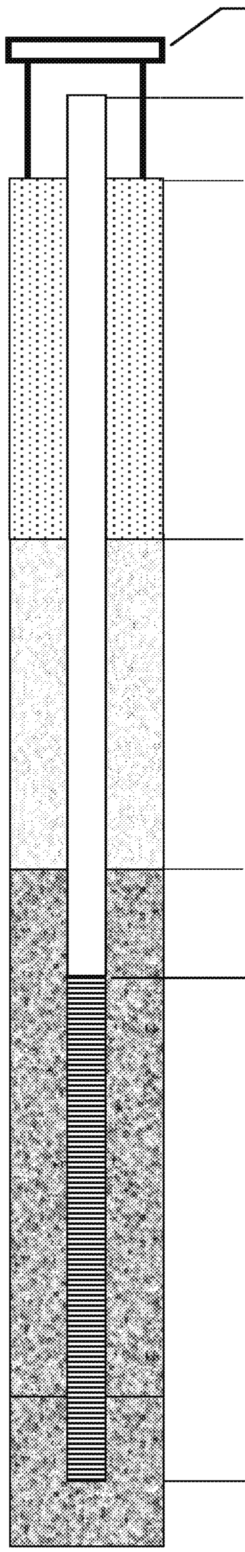
CONSTRUCTION MATERIALS USED:

3.5 Bags of Sand

1 Bags/Buckets Bentonite Pellets

6 Bags Portland for Grout

___ Bags Concrete/Sakrete



Protective Casing with Locking Cap

Top of Casing Elevation: 444.34 ft.
Stick-up: 2.56 ft.

Land Surface Elevation: 441.78 ft.

Grout; Type: Portland cement/ Grout

Borehole Diameter: 6 inch

Casing Diameter: 2 Inch
Casing Material: PVC
Top of Seal: 62 ft*

Seal Type: Bentonite Pellets

Top of Sand/Gravel Pack: 64 ft*

Top of Well Screen 65 ft*

Sand/Gravel Pack; Type: Global #5

Screen Diameter: 2 Inch
Screen Slot-Size: 0.010 Inch
Screen Material: PVC

Bottom of Well Screen 70 ft.*

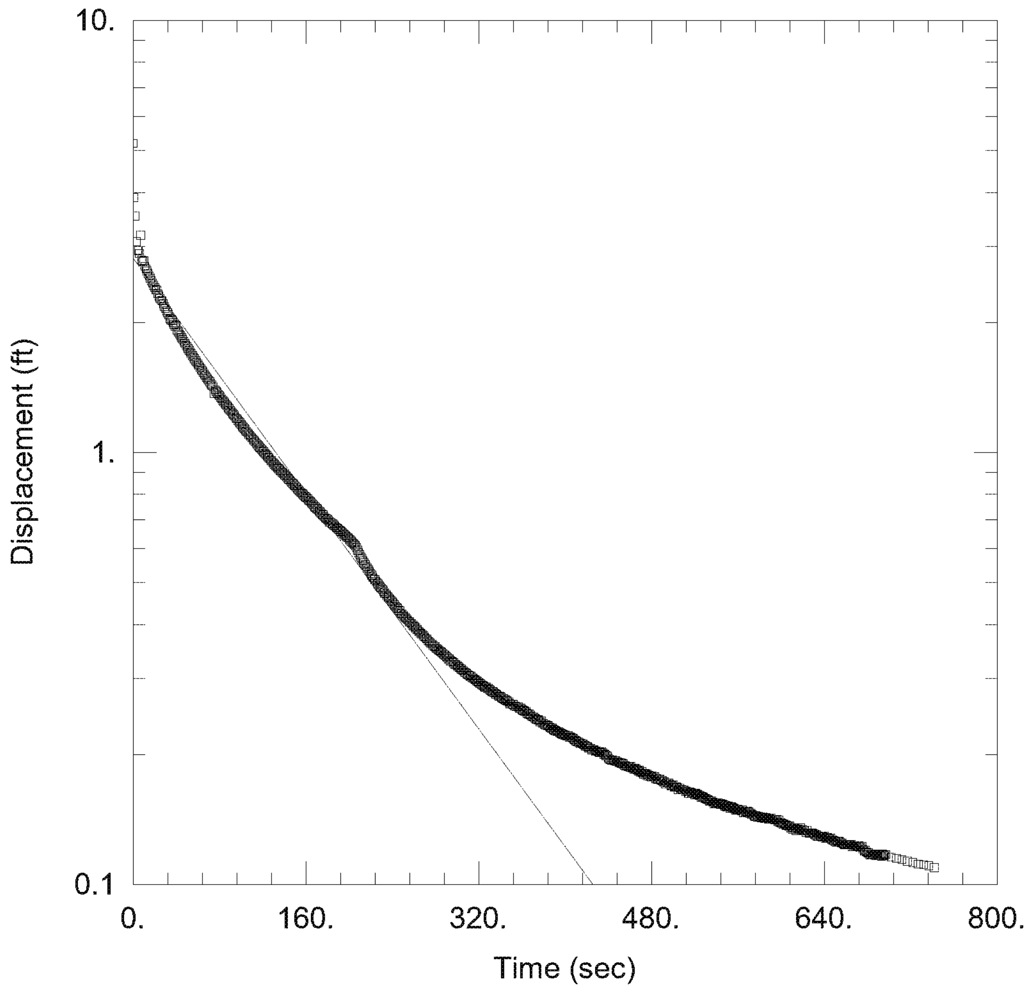
Base of Borehole: 70 ft.*

Total Depth of Well Below Top of Casing: 72.56 ft.

*Indicates Depth Below Land Surface

APPENDIX E

SLUG TEST RESULTS



CF-19-08D-IN1

Data Set: \...\CF-19-08D-IN1.aqt
Date: 05/31/19 Time: 14:23:10

PROJECT INFORMATION

Company: AGES, Inc.
Client: OVEC
Project: 2019042-07
Location: Clifty Creek
Test Well: CF-19-08D
Test Date: 4/16/2019

AQUIFER DATA

Saturated Thickness: 10. ft
Anisotropy Ratio (Kz/Kr): 1.

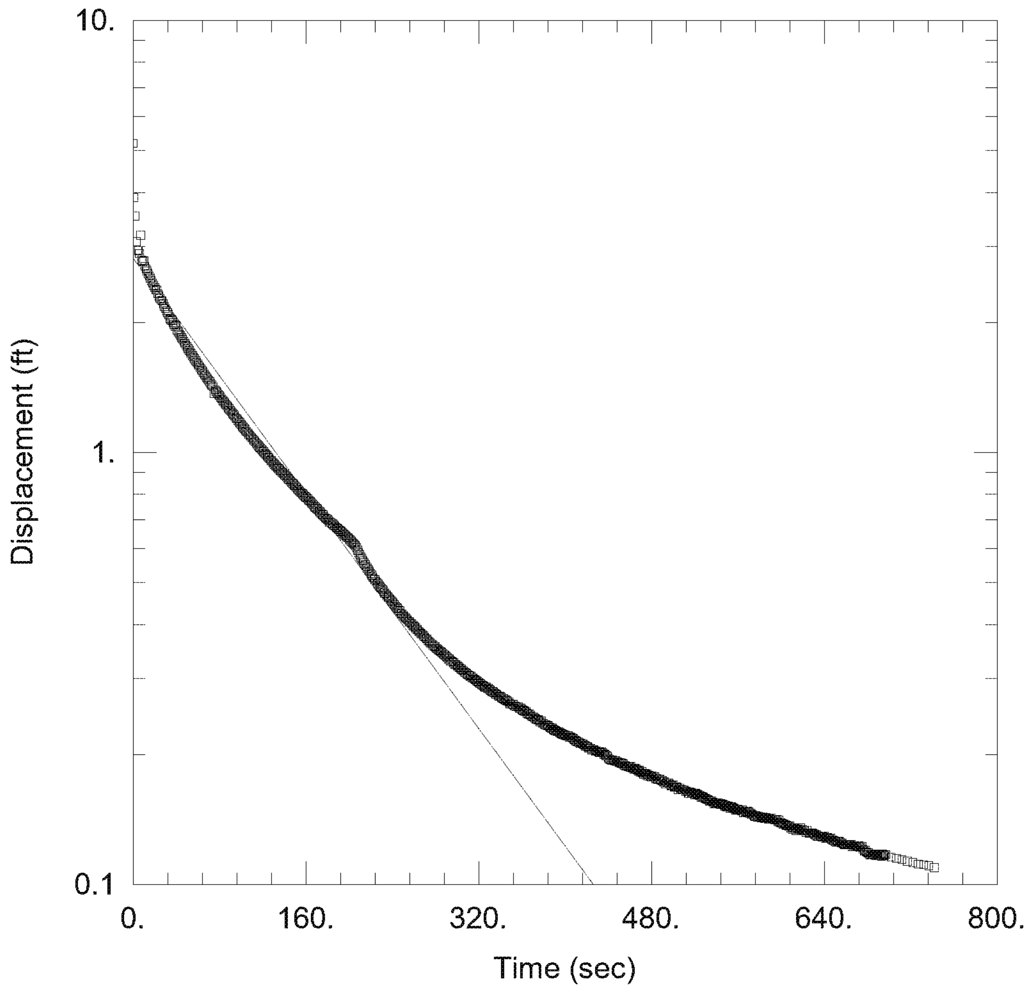
WELL DATA (CF-19-08D)

Initial Displacement: 5.191 ft
Total Well Penetration Depth: 89.9 ft
Casing Radius: 0.083 ft
Static Water Column Height: 65.31 ft
Screen Length: 10. ft
Well Radius: 0.083 ft
Gravel Pack Porosity: 0.

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice

K = 1.361E-5 ft/sec
y0 = 2.823 ft



CF-19-08D-IN1

Data Set: \...\CF-19-08D-IN1.aqt
Date: 05/31/19
Time: 14:23:38

PROJECT INFORMATION

Company: AGES, Inc.
Client: OVEC
Project: 2019042-07
Location: Clifty Creek
Test Well: CF-19-08D
Test Date: 4/16/2019

AQUIFER DATA

Saturated Thickness: 10. ft
Anisotropy Ratio (Kz/Kr): 1.

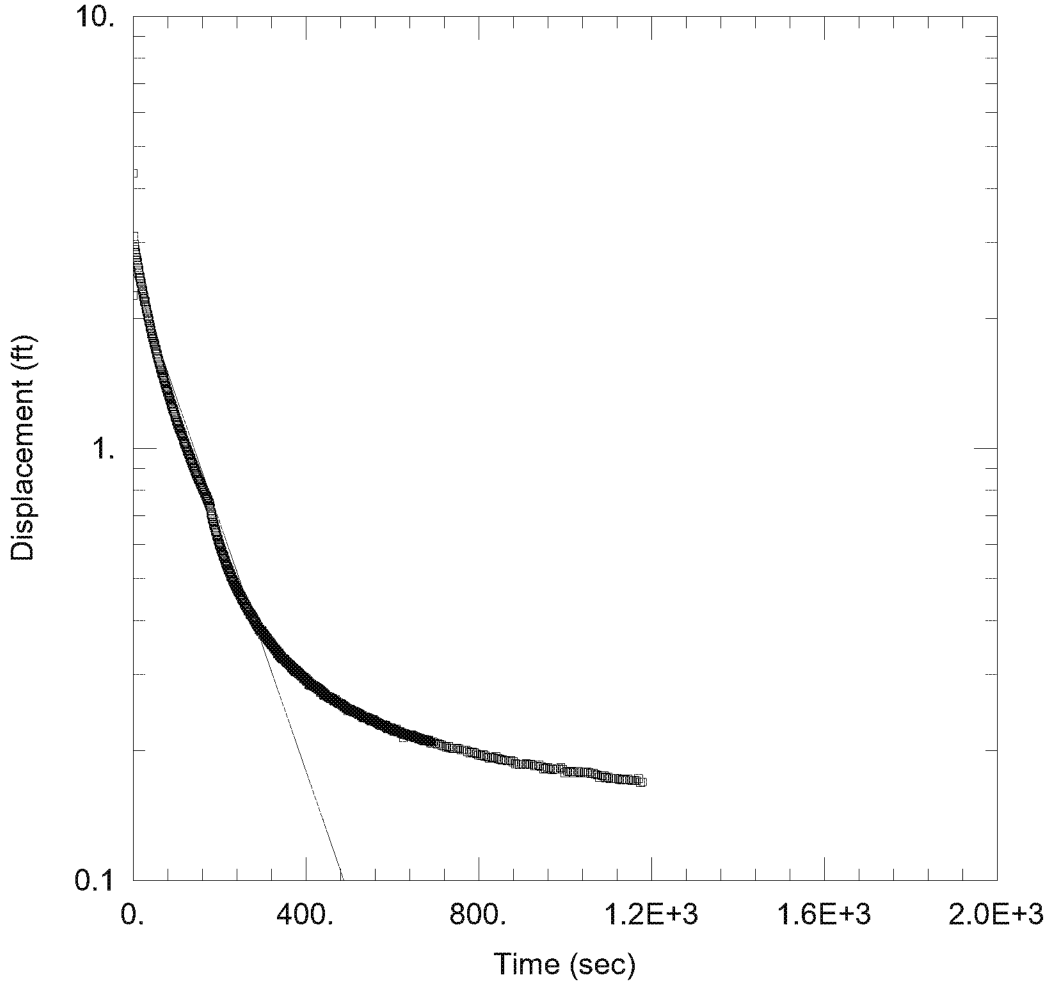
WELL DATA (CF-19-08D)

Initial Displacement: 5.191 ft
Total Well Penetration Depth: 89.9 ft
Casing Radius: 0.083 ft
Static Water Column Height: 65.31 ft
Screen Length: 10. ft
Well Radius: 0.083 ft
Gravel Pack Porosity: 0.

SOLUTION

Aquifer Model: Confined
Solution Method: Hvorslev

K = 1.429E-5 ft/sec
y0 = 2.822 ft



CF-19-08D-IN2

Data Set: \...\CF-19-08D-IN2.aqt
Date: 05/31/19 Time: 14:27:00

PROJECT INFORMATION

Company: AGES, Inc.
Client: OVEC
Project: 2019042-07
Location: Clifty Creek
Test Well: CF-19-08D
Test Date: 4/16/2019

AQUIFER DATA

Saturated Thickness: 10. ft
Anisotropy Ratio (Kz/Kr): 1.

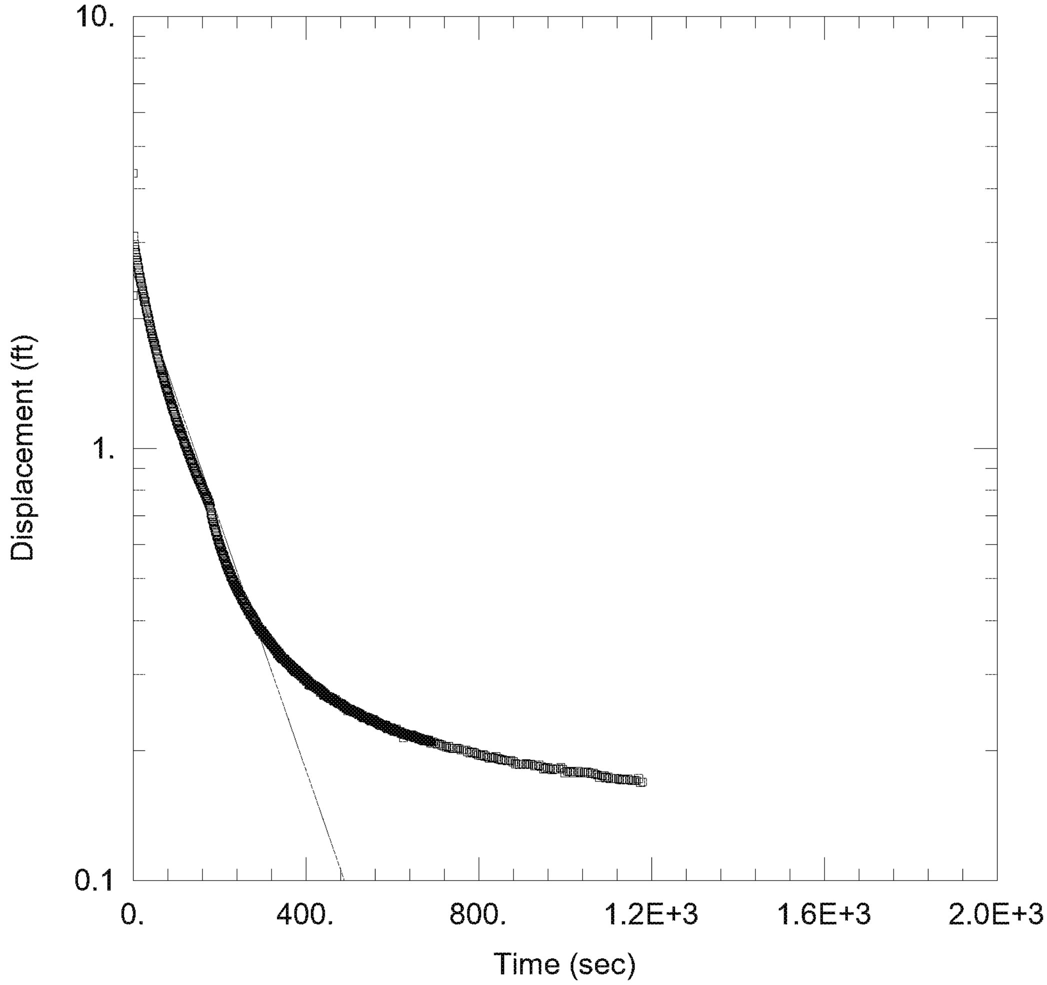
WELL DATA (CF-19-08D)

Initial Displacement: 4.335 ft
Total Well Penetration Depth: 89.9 ft
Casing Radius: 0.083 ft
Static Water Column Height: 65.31 ft
Screen Length: 10. ft
Well Radius: 0.083 ft
Gravel Pack Porosity: 0.

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice

K = 1.152E-5 ft/sec
y0 = 2.561 ft



CF-19-08D-IN2

Data Set: \...\CF-19-08D-IN2.aqt
Date: 05/31/19
Time: 14:27:28

PROJECT INFORMATION

Company: AGES, Inc.
Client: OVEC
Project: 2019042-07
Location: Clifty Creek
Test Well: CF-19-08D
Test Date: 4/16/2019

AQUIFER DATA

Saturated Thickness: 10. ft
Anisotropy Ratio (Kz/Kr): 1.

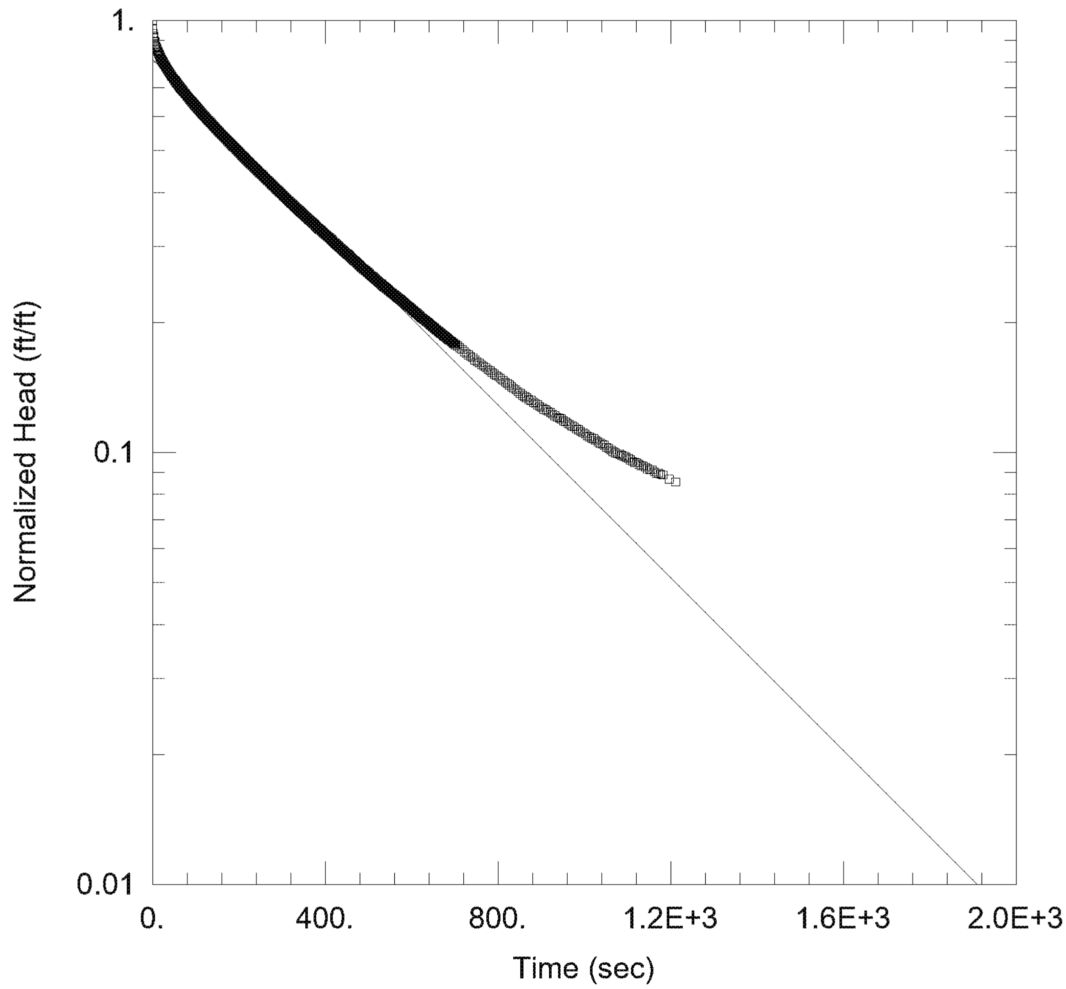
WELL DATA (CF-19-08D)

Initial Displacement: 4.335 ft
Total Well Penetration Depth: 89.9 ft
Casing Radius: 0.083 ft
Static Water Column Height: 65.31 ft
Screen Length: 10. ft
Well Radius: 0.083 ft
Gravel Pack Porosity: 0.

SOLUTION

Aquifer Model: Confined
Solution Method: Hvorslev

K = 1.209E-5 ft/sec
y0 = 2.559 ft



CF-19-08D-OUT1

Data Set: \...\CF-19-08D-OUT1.aqt
Date: 05/31/19 Time: 14:18:00

PROJECT INFORMATION

Company: AGES, Inc.
Client: OVEC
Project: 2019042-07
Location: Clifty Creek
Test Well: CF-19-08D
Test Date: 4/16/2019

AQUIFER DATA

Saturated Thickness: 10. ft Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (CF-19-08D)

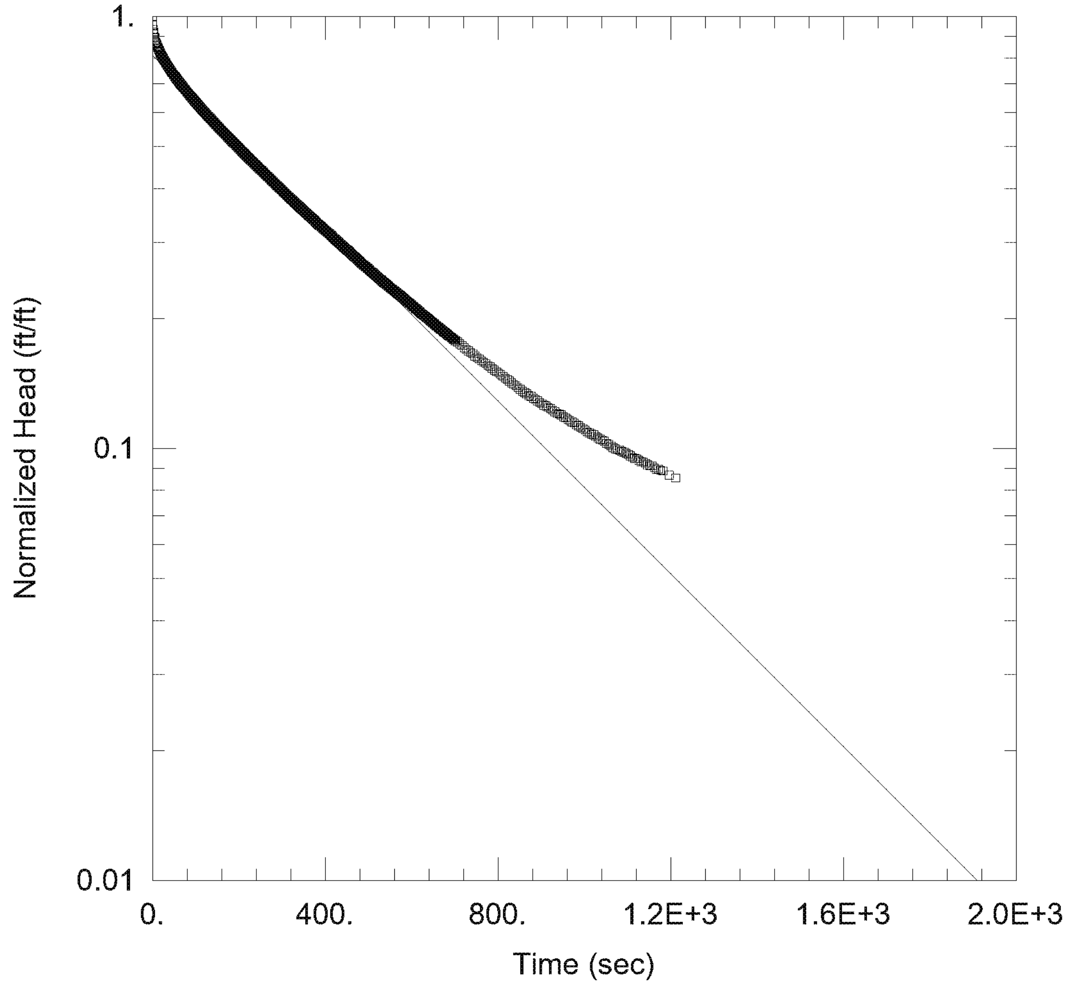
Initial Displacement: -3.113 ft
Total Well Penetration Depth: 89.9 ft
Casing Radius: 0.083 ft

Static Water Column Height: 65.31 ft
Screen Length: 10. ft
Well Radius: 0.083 ft
Gravel Pack Porosity: 0.

SOLUTION

Aquifer Model: Confined Solution Method: Bouwer-Rice

K = 3.995E-6 ft/sec y0 = -2.537 ft



CF-19-08D-OUT1

Data Set: \...\CF-19-08D-OUT1.aqt
Date: 05/31/19 Time: 14:19:05

PROJECT INFORMATION

Company: AGES, Inc.
Client: OVEC
Project: 2019042-07
Location: Clifty Creek
Test Well: CF-19-08D
Test Date: 4/16/2019

AQUIFER DATA

Saturated Thickness: 10. ft
Anisotropy Ratio (Kz/Kr): 1.

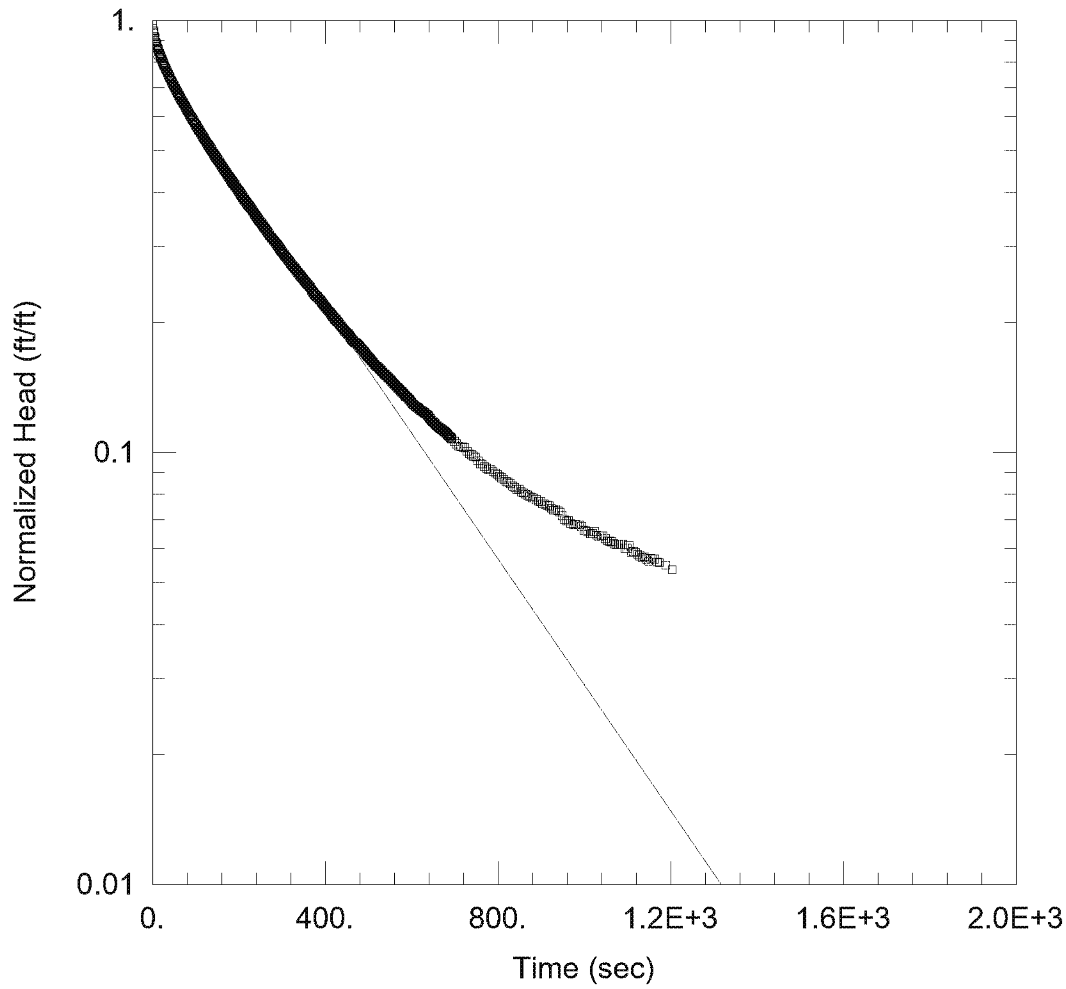
WELL DATA (CF-19-08D)

Initial Displacement: -3.113 ft
Total Well Penetration Depth: 89.9 ft
Casing Radius: 0.083 ft
Static Water Column Height: 65.31 ft
Screen Length: 10. ft
Well Radius: 0.083 ft
Gravel Pack Porosity: 0.

SOLUTION

Aquifer Model: Confined
Solution Method: Hvorslev

K = 4.201E-6 ft/sec
y0 = -2.537 ft



CF-19-08D-OUT2

Data Set: \...\CF-19-08D-OUT2.aqt
Date: 05/31/19 Time: 14:34:49

PROJECT INFORMATION

Company: AGES, Inc.
Client: OVEC
Project: 2019042-07
Location: Clifty Creek
Test Well: CF-19-08D
Test Date: 4/16/2019

AQUIFER DATA

Saturated Thickness: 10. ft Anisotropy Ratio (Kz/Kr): 1.

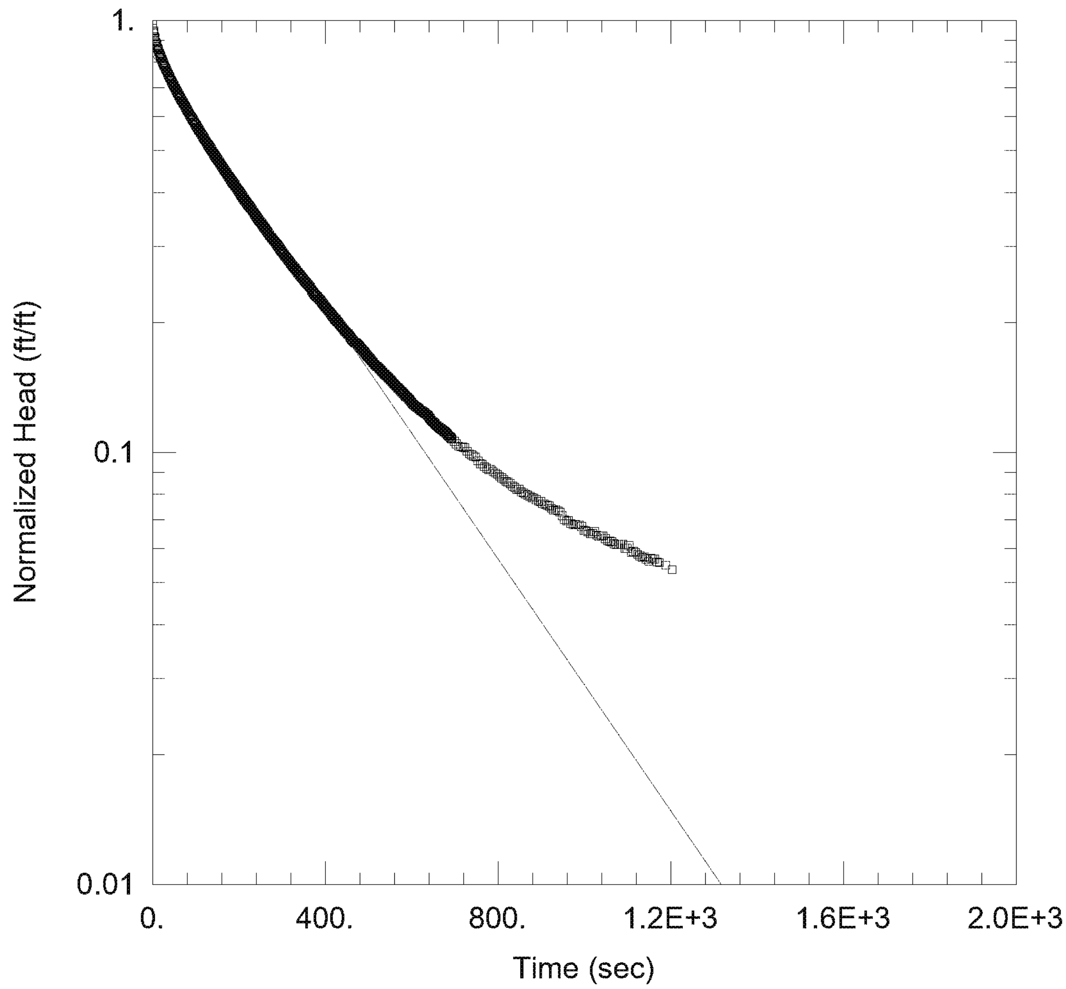
WELL DATA (CF-19-08D)

Initial Displacement: -2.969 ft
Total Well Penetration Depth: 89.9 ft
Casing Radius: 0.083 ft
Static Water Column Height: 65.31 ft
Screen Length: 10. ft
Well Radius: 0.083 ft
Gravel Pack Porosity: 0.

SOLUTION

Aquifer Model: Confined Solution Method: Bouwer-Rice

K = 5.823E-6 ft/sec y0 = -2.472 ft



CF-19-08D-OUT2

Data Set: \...\CF-19-08D-OUT2.aqt
Date: 05/31/19
Time: 14:35:28

PROJECT INFORMATION

Company: AGES, Inc.
Client: OVEC
Project: 2019042-07
Location: Clifty Creek
Test Well: CF-19-08D
Test Date: 4/16/2019

AQUIFER DATA

Saturated Thickness: 10. ft
Anisotropy Ratio (Kz/Kr): 1.

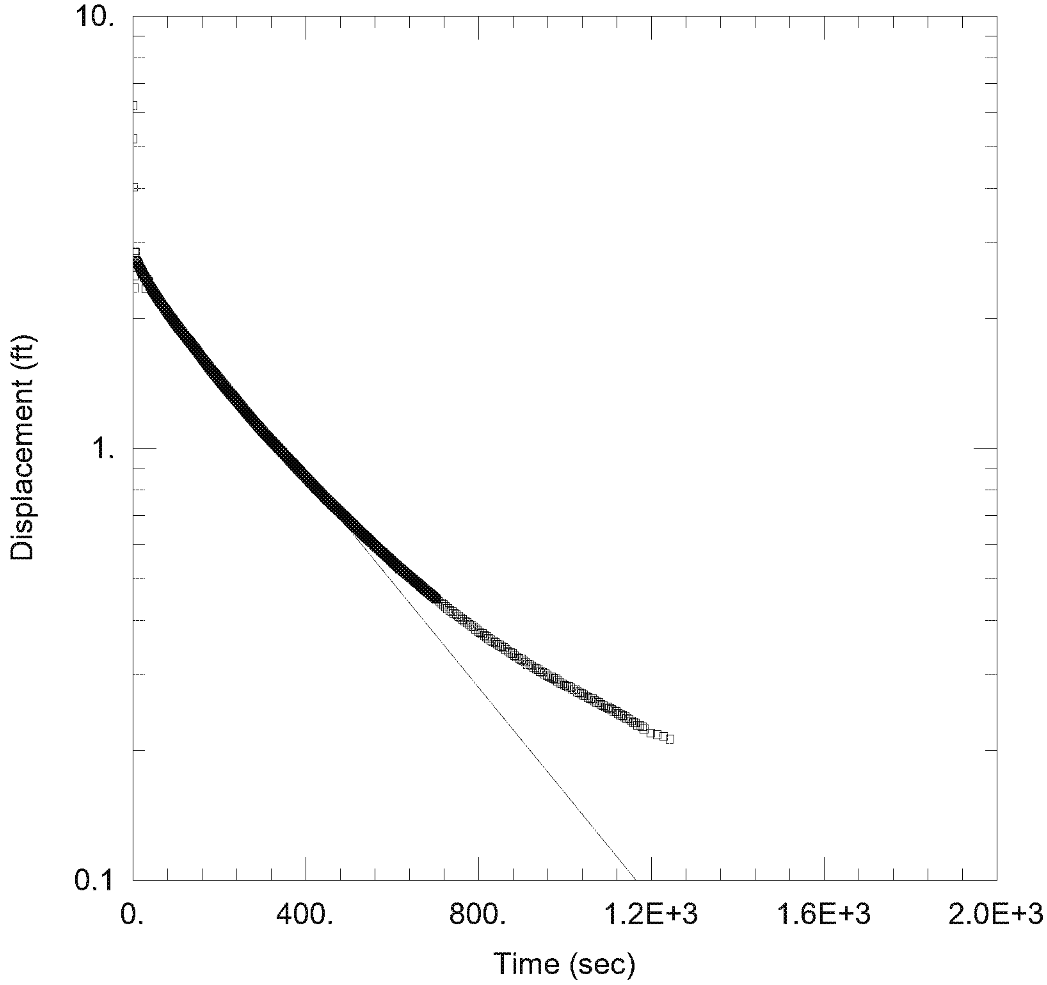
WELL DATA (CF-19-08D)

Initial Displacement: -2.969 ft
Total Well Penetration Depth: 89.9 ft
Casing Radius: 0.083 ft
Static Water Column Height: 65.31 ft
Screen Length: 10. ft
Well Radius: 0.083 ft
Gravel Pack Porosity: 0.

SOLUTION

Aquifer Model: Confined
Solution Method: Hvorslev

K = 6.122E-6 ft/sec
y0 = -2.471 ft



CF-19-14-IN1

Data Set: \...\cf-19-14-in1.aqt
Date: 05/30/19 Time: 14:52:50

PROJECT INFORMATION

Company: AGES, Inc.
Client: OVEC
Project: 2019042-07
Location: Clifty Creek
Test Well: CF-19-14
Test Date: 4/16/2019

AQUIFER DATA

Saturated Thickness: 14.05 ft
Anisotropy Ratio (Kz/Kr): 1.

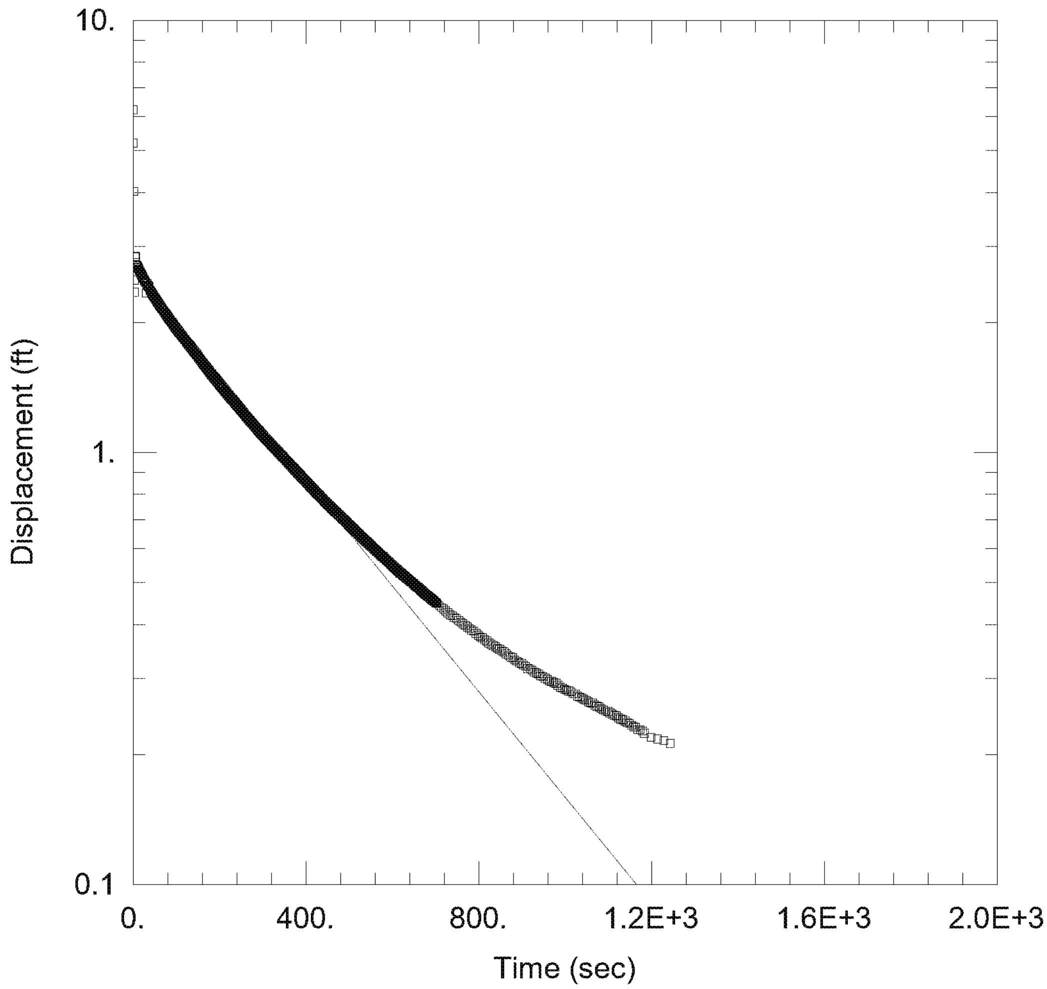
WELL DATA (CF-19-14)

Initial Displacement: 6.214 ft
Total Well Penetration Depth: 22. ft
Casing Radius: 0.0833 ft
Static Water Column Height: 14.05 ft
Screen Length: 10. ft
Well Radius: 0.0833 ft
Gravel Pack Porosity: 0.

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice

K = 4.099E-6 ft/sec
y0 = 2.666 ft



CF-19-14-IN1

Data Set: \...\cf-19-14-in1.aqt
Date: 05/30/19 Time: 14:53:35

PROJECT INFORMATION

Company: AGES, Inc.
Client: OVEC
Project: 2019042-07
Location: Clifty Creek
Test Well: CF-19-14
Test Date: 4/16/2019

AQUIFER DATA

Saturated Thickness: 14.05 ft Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (CF-19-14)

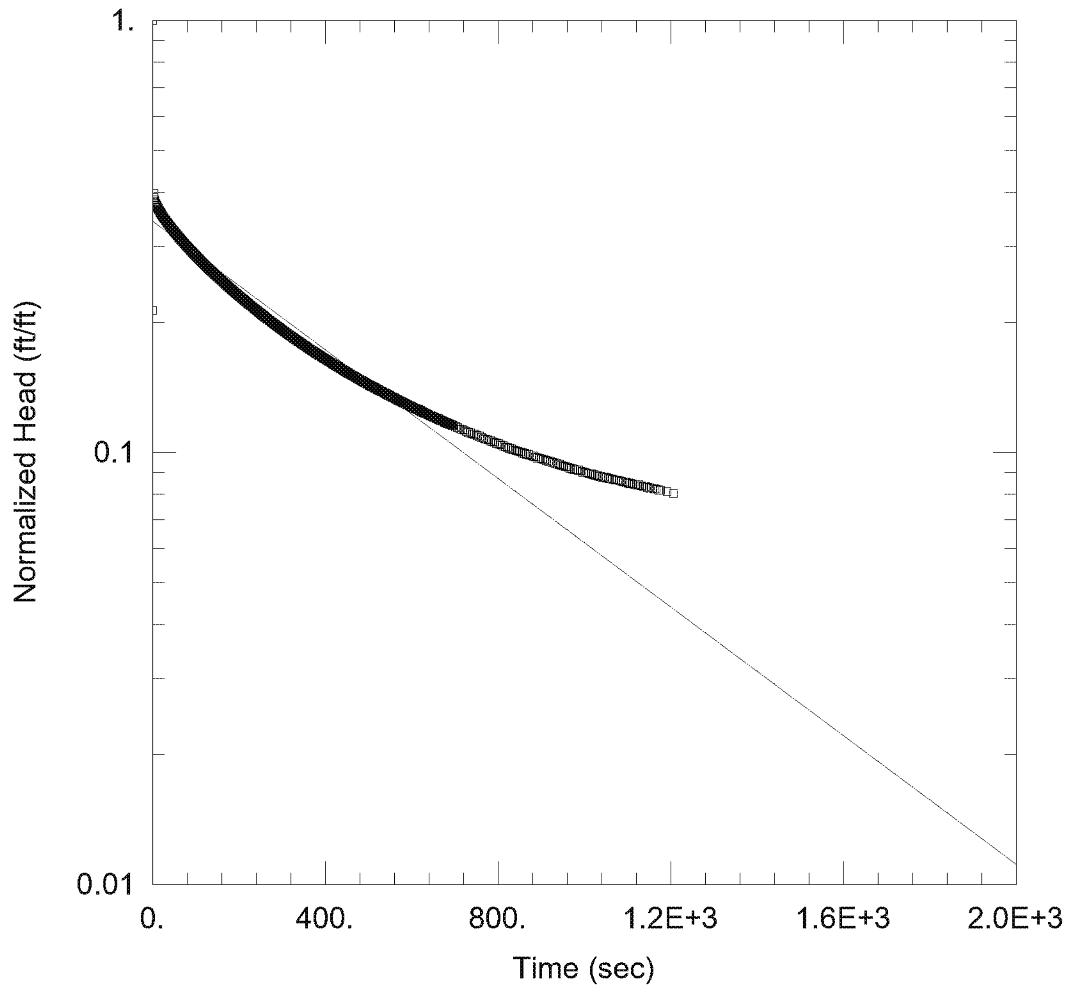
Initial Displacement: 6.214 ft
Total Well Penetration Depth: 22. ft
Casing Radius: 0.0833 ft

Static Water Column Height: 14.05 ft
Screen Length: 10. ft
Well Radius: 0.0833 ft
Gravel Pack Porosity: 0.

SOLUTION

Aquifer Model: Confined Solution Method: Hvorslev

K = 5.354E-6 ft/sec y0 = 2.666 ft



CF-19-14-OUT2

Data Set: \...\CF-19-14-OUT2.aqt
Date: 05/30/19 Time: 14:57:13

PROJECT INFORMATION

Company: AGES, Inc.
Client: OVEC
Project: 2019042-07
Location: Clifty Creek
Test Well: CF-19-14
Test Date: 4/16/2019

AQUIFER DATA

Saturated Thickness: 14.05 ft Anisotropy Ratio (Kz/Kr): 1.

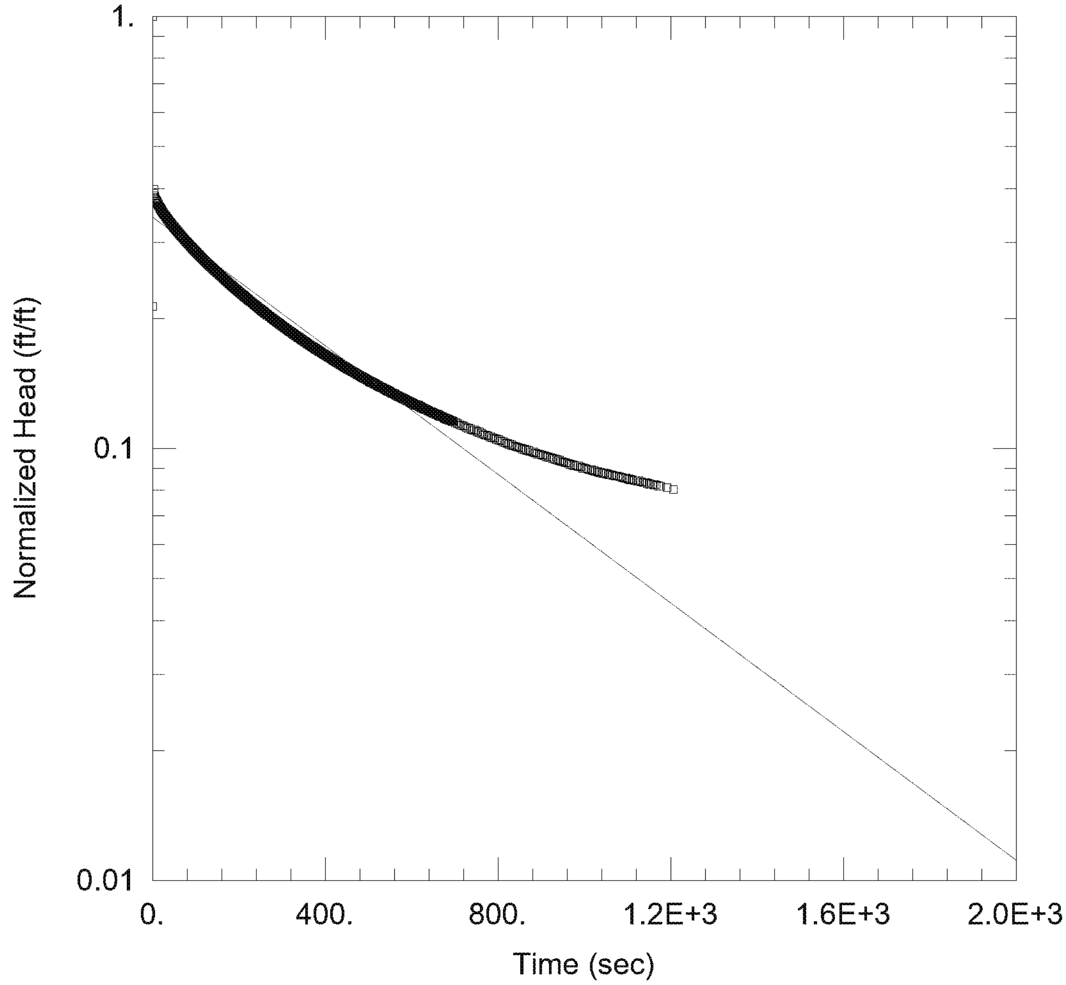
WELL DATA (CF-19-14)

Initial Displacement: -7.572 ft
Total Well Penetration Depth: 22.24 ft
Casing Radius: 0.0833 ft
Static Water Column Height: 14.05 ft
Screen Length: 10. ft
Well Radius: 0.0833 ft
Gravel Pack Porosity: 0.

SOLUTION

Aquifer Model: Confined Solution Method: Bouwer-Rice

K = 2.498E-6 ft/sec y0 = -2.602 ft



CF-19-14-OUT2

Data Set: \...\CF-19-14-OUT2.aqt
Date: 05/30/19 Time: 14:58:10

PROJECT INFORMATION

Company: AGES, Inc.
Client: OVEC
Project: 2019042-07
Location: Clifty Creek
Test Well: CF-19-14
Test Date: 4/16/2019

AQUIFER DATA

Saturated Thickness: 14.05 ft
Anisotropy Ratio (Kz/Kr): 1.

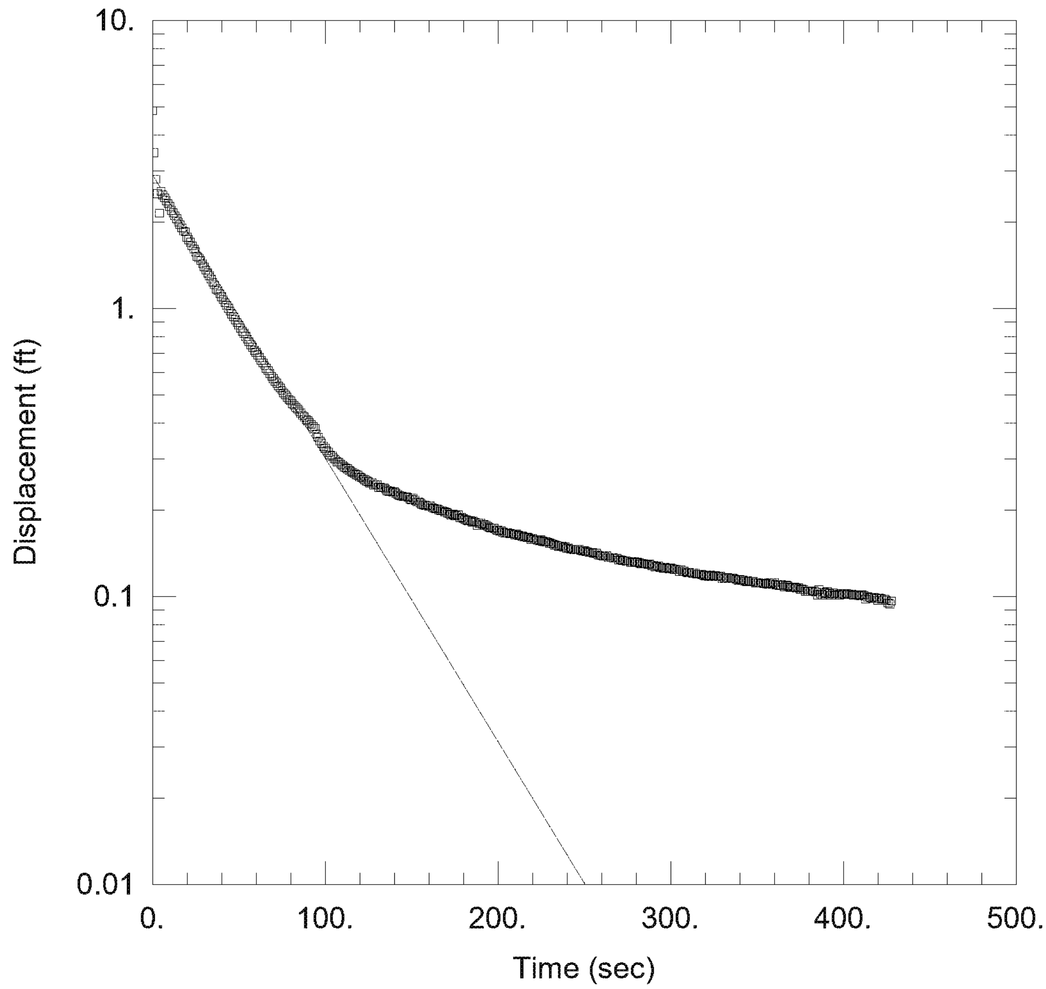
WELL DATA (CF-19-14)

Initial Displacement: -7.572 ft
Total Well Penetration Depth: 22.24 ft
Casing Radius: 0.0833 ft
Static Water Column Height: 14.05 ft
Screen Length: 10. ft
Well Radius: 0.0833 ft
Gravel Pack Porosity: 0.

SOLUTION

Aquifer Model: Confined
Solution Method: Hvorslev

K = 3.258E-6 ft/sec
y0 = -2.602 ft



CF-19-15D-IN1

Data Set: \...\CF-19-15DIN1.aqt
Date: 05/31/19 Time: 13:51:42

PROJECT INFORMATION

Company: AGES, Inc.
Client: OVEC
Project: 2019042-07
Location: Clifty Creek
Test Well: CF-19-15D
Test Date: 4/16/2019

AQUIFER DATA

Saturated Thickness: 8. ft
Anisotropy Ratio (Kz/Kr): 1.

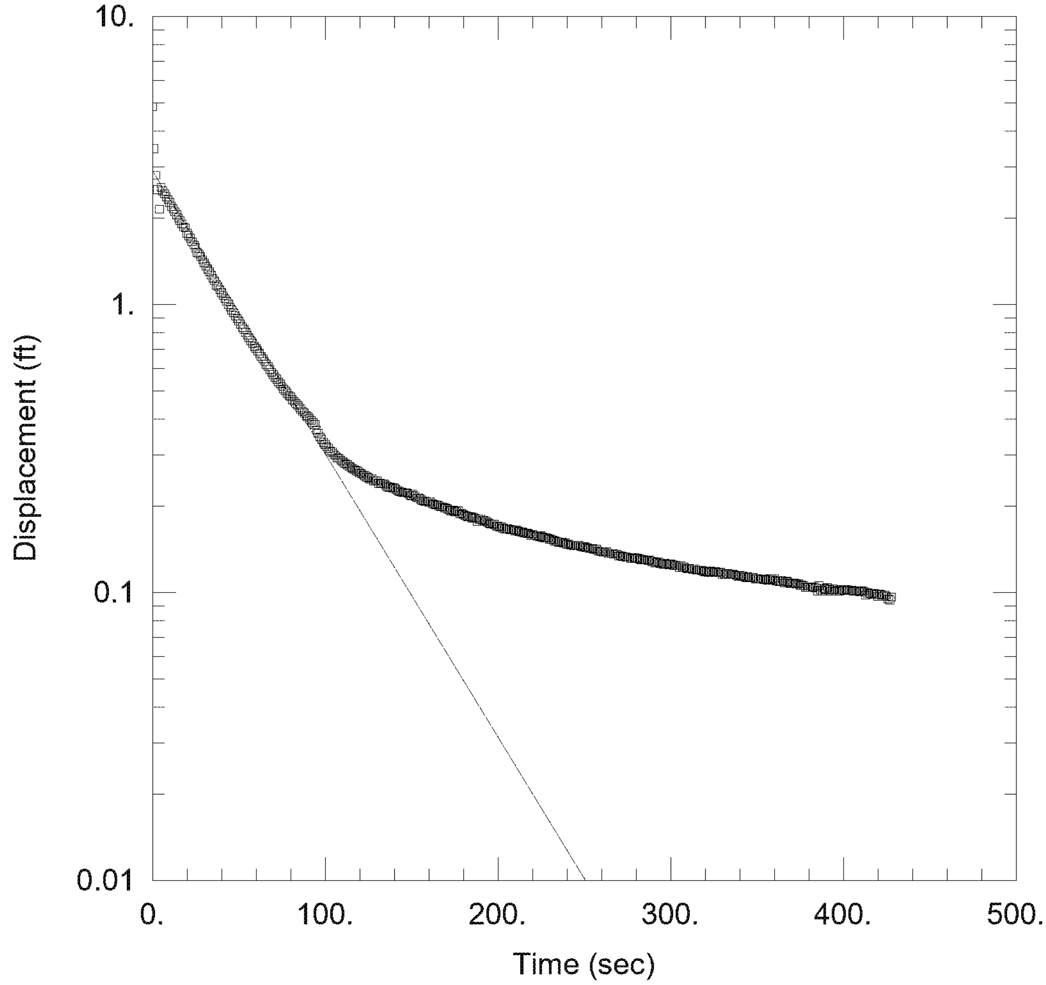
WELL DATA (CF-19-15D)

Initial Displacement: 4.865 ft
Total Well Penetration Depth: 72.07 ft
Casing Radius: 0.083 ft
Static Water Column Height: 53.91 ft
Screen Length: 10. ft
Well Radius: 0.083 ft
Gravel Pack Porosity: 0.

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice

K = 4.728E-5 ft/sec
y0 = 2.923 ft



CF-19-15D-IN1

Data Set: \...\CF-19-15DIN1.aqt
Date: 05/31/19 Time: 13:52:37

PROJECT INFORMATION

Company: AGES, Inc.
Client: OVEC
Project: 2019042-07
Location: Clifty Creek
Test Well: CF-19-15D
Test Date: 4/16/2019

AQUIFER DATA

Saturated Thickness: 8. ft
Anisotropy Ratio (Kz/Kr): 1.

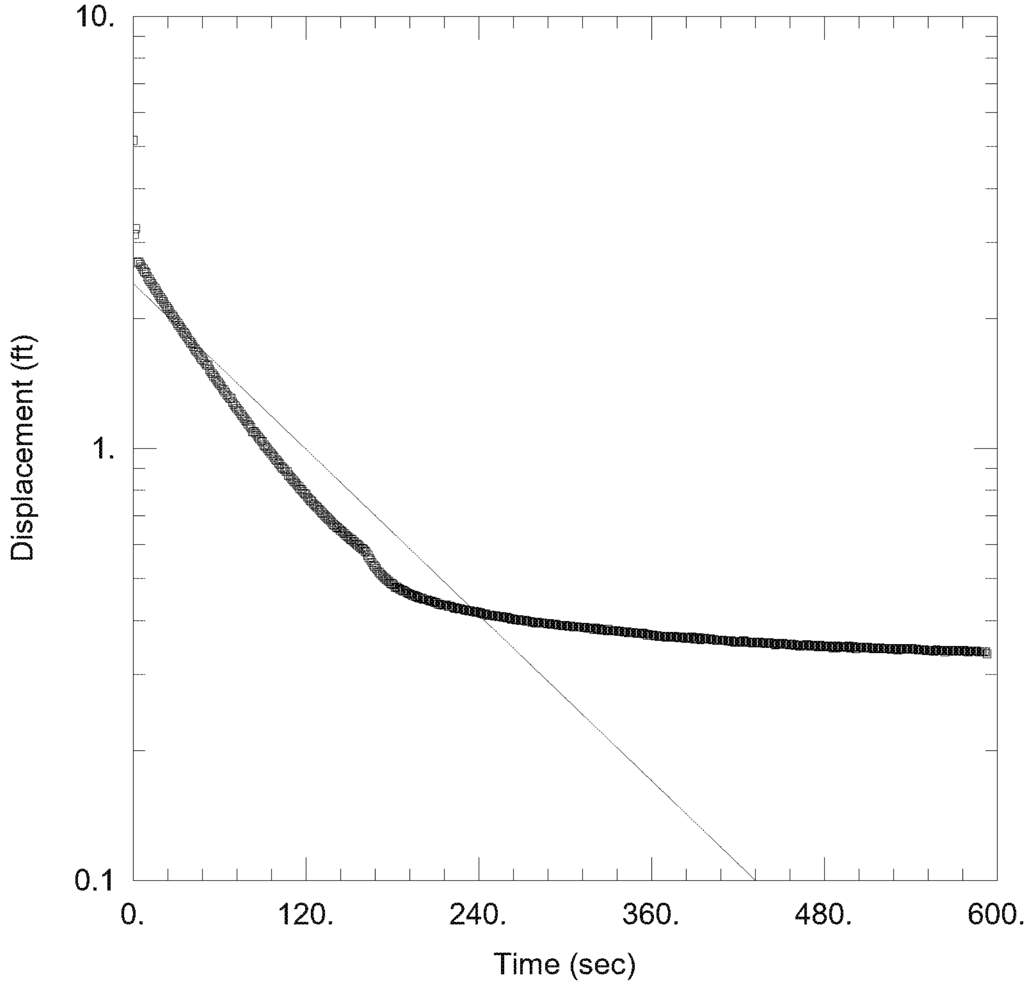
WELL DATA (CF-19-15D)

Initial Displacement: 4.865 ft
Total Well Penetration Depth: 72.07 ft
Casing Radius: 0.083 ft
Static Water Column Height: 53.91 ft
Screen Length: 10. ft
Well Radius: 0.083 ft
Gravel Pack Porosity: 0.

SOLUTION

Aquifer Model: Confined
Solution Method: Hvorslev

K = 5.163E-5 ft/sec
y0 = 2.922 ft



CF-19-15D-IN2

Data Set: \...\CF-19-15D-IN2.aqt
Date: 05/31/19
Time: 13:55:33

PROJECT INFORMATION

Company: AGES, Inc.
Client: OVEC
Project: 2019042-07
Location: Clifty Creek
Test Well: CF-19-15D
Test Date: 4/16/2019

AQUIFER DATA

Saturated Thickness: 8. ft
Anisotropy Ratio (Kz/Kr): 1.

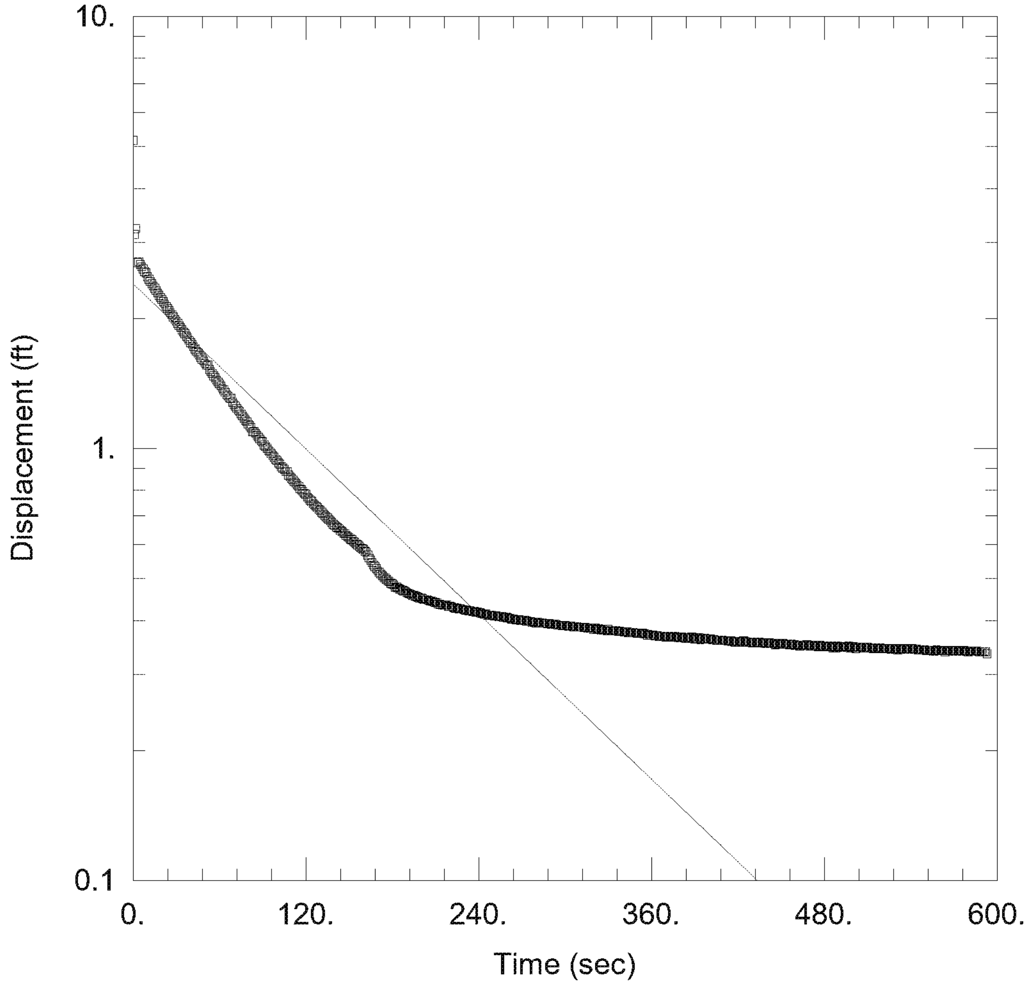
WELL DATA (CF-19-15D)

Initial Displacement: 5.168 ft
Total Well Penetration Depth: 72.07 ft
Casing Radius: 0.083 ft
Static Water Column Height: 53.91 ft
Screen Length: 10. ft
Well Radius: 0.083 ft
Gravel Pack Porosity: 0.

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice

K = 1.536E-5 ft/sec
y0 = 2.415 ft



CF-19-15D-IN2

Data Set: \...\CF-19-15D-IN2.aqt
Date: 05/31/19 Time: 13:56:41

PROJECT INFORMATION

Company: AGES, Inc.
Client: OVEC
Project: 2019042-07
Location: Clifty Creek
Test Well: CF-19-15D
Test Date: 4/16/2019

AQUIFER DATA

Saturated Thickness: 8. ft Anisotropy Ratio (Kz/Kr): 1.

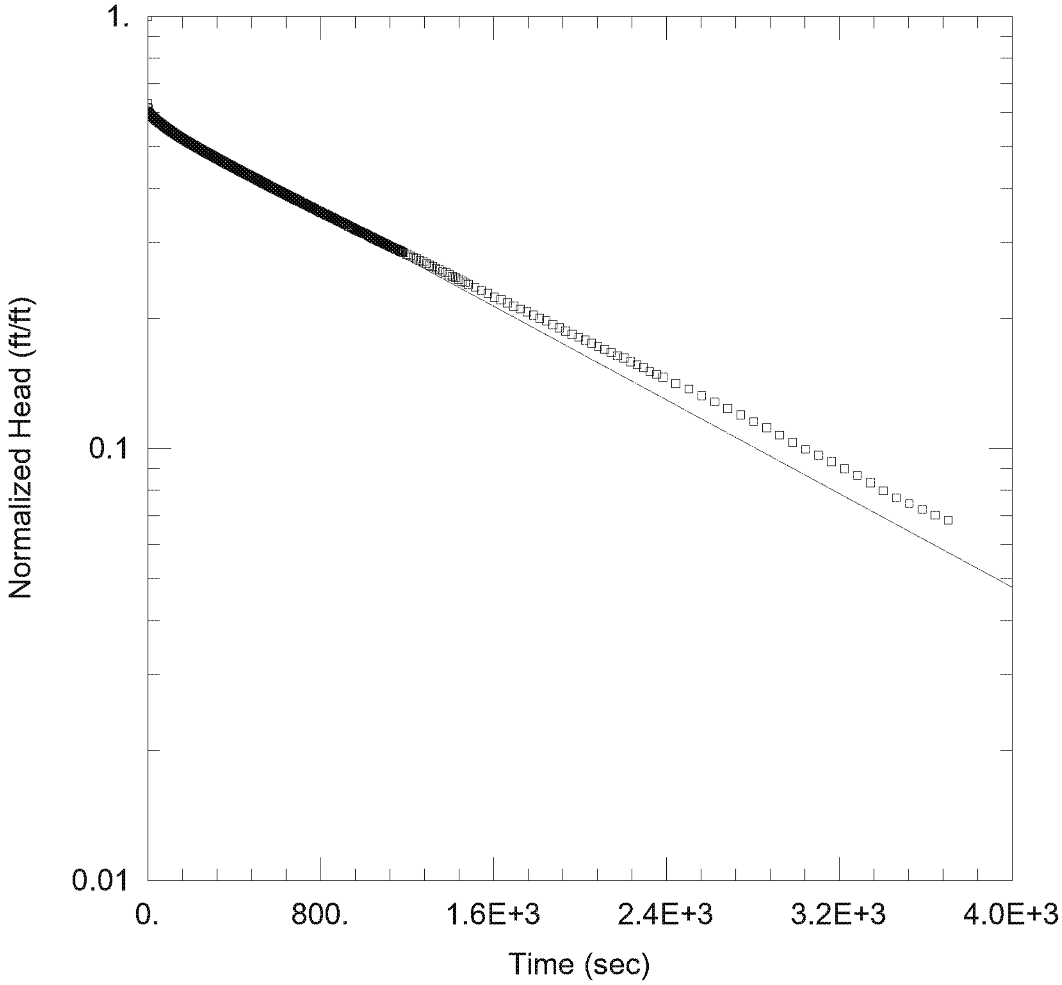
WELL DATA (CF-19-15D)

Initial Displacement: 5.168 ft
Total Well Penetration Depth: 72.07 ft
Casing Radius: 0.083 ft
Static Water Column Height: 53.91 ft
Screen Length: 10. ft
Well Radius: 0.083 ft
Gravel Pack Porosity: 0.

SOLUTION

Aquifer Model: Confined Solution Method: Hvorslev

K = 1.673E-5 ft/sec y0 = 2.41 ft



CF-15D-OUT1

Data Set: \...\CF-19-15D-OUT1.aqt
Date: 05/31/19 Time: 14:05:05

PROJECT INFORMATION

Company: AGES, Inc.
Client: OVEC
Project: 2019042-07
Location: Clifty Creek
Test Well: CF-19-15D
Test Date: 4/16/2019

AQUIFER DATA

Saturated Thickness: 8. ft
Anisotropy Ratio (Kz/Kr): 1.

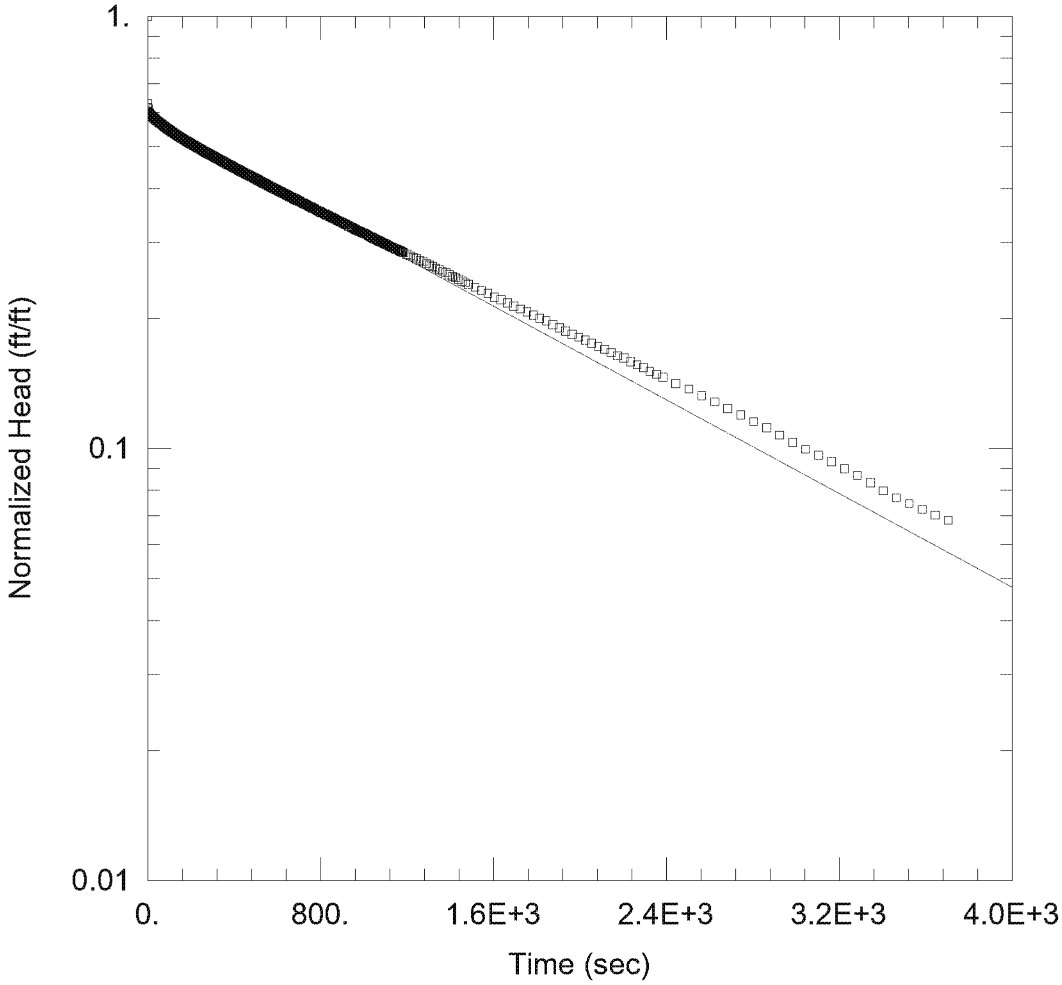
WELL DATA (CF-19-15D)

Initial Displacement: -5.008 ft
Total Well Penetration Depth: 72.07 ft
Casing Radius: 0.083 ft
Static Water Column Height: 53.91 ft
Screen Length: 10. ft
Well Radius: 0.083 ft
Gravel Pack Porosity: 0.

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice

K = 1.303E-6 ft/sec
y0 = -2.906 ft



CF-15D-OUT1

Data Set: \...\CF-19-15D-OUT1.aqt
Date: 05/31/19 Time: 14:05:43

PROJECT INFORMATION

Company: AGES, Inc.
Client: OVEC
Project: 2019042-07
Location: Clifty Creek
Test Well: CF-19-15D
Test Date: 4/16/2019

AQUIFER DATA

Saturated Thickness: 8. ft Anisotropy Ratio (Kz/Kr): 1.

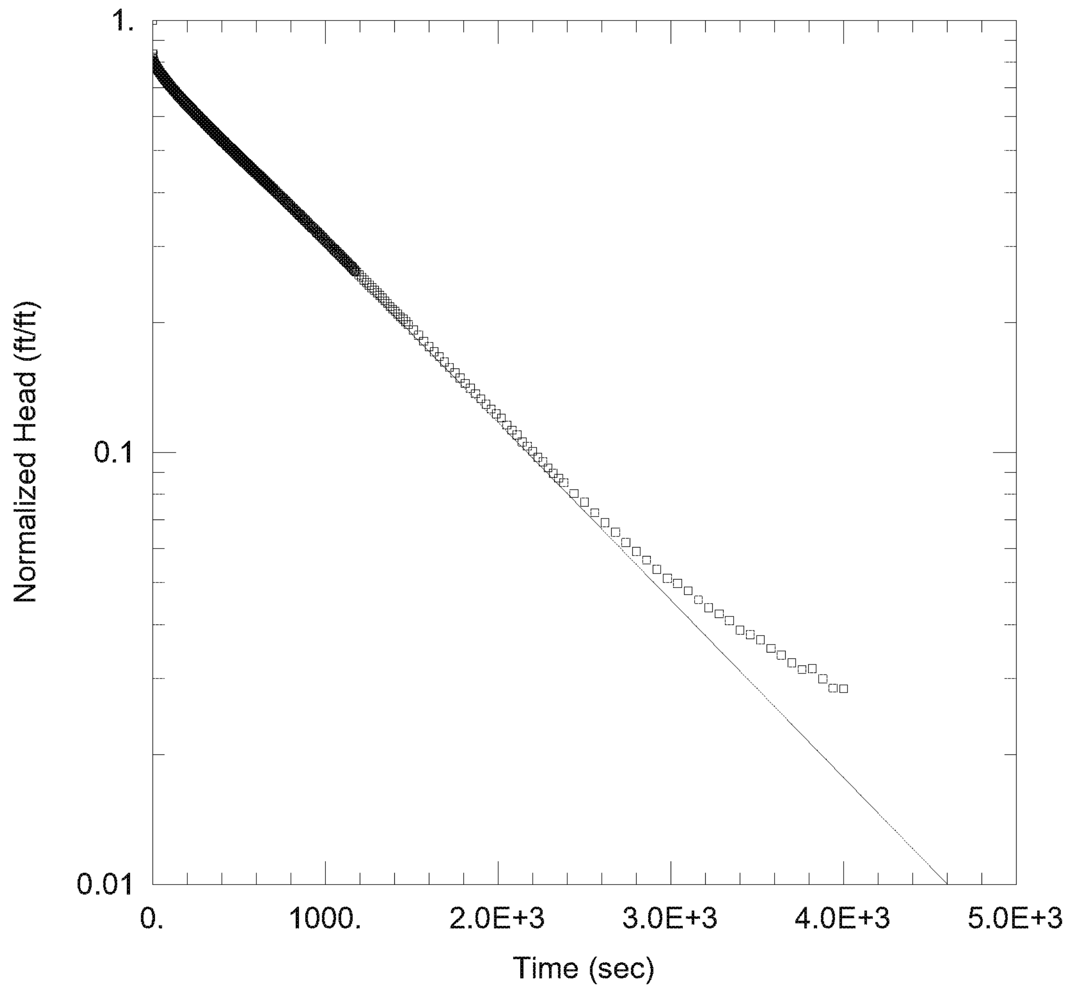
WELL DATA (CF-19-15D)

Initial Displacement: -5.008 ft
Total Well Penetration Depth: 72.07 ft
Casing Radius: 0.083 ft
Static Water Column Height: 53.91 ft
Screen Length: 10. ft
Well Radius: 0.083 ft
Gravel Pack Porosity: 0.

SOLUTION

Aquifer Model: Confined Solution Method: Hvorslev

K = 1.424E-6 ft/sec y0 = -2.906 ft



CF-19-15D-OUT2

Data Set: \...\CF-19-15D-OUT2.aqt
Date: 05/31/19 Time: 14:13:00

PROJECT INFORMATION

Company: AGES, Inc.
Client: OVEC
Project: 2019042-07
Location: Clifty Creek
Test Well: CF-19-15D
Test Date: 4/16/2019

AQUIFER DATA

Saturated Thickness: 8. ft
Anisotropy Ratio (Kz/Kr): 1.

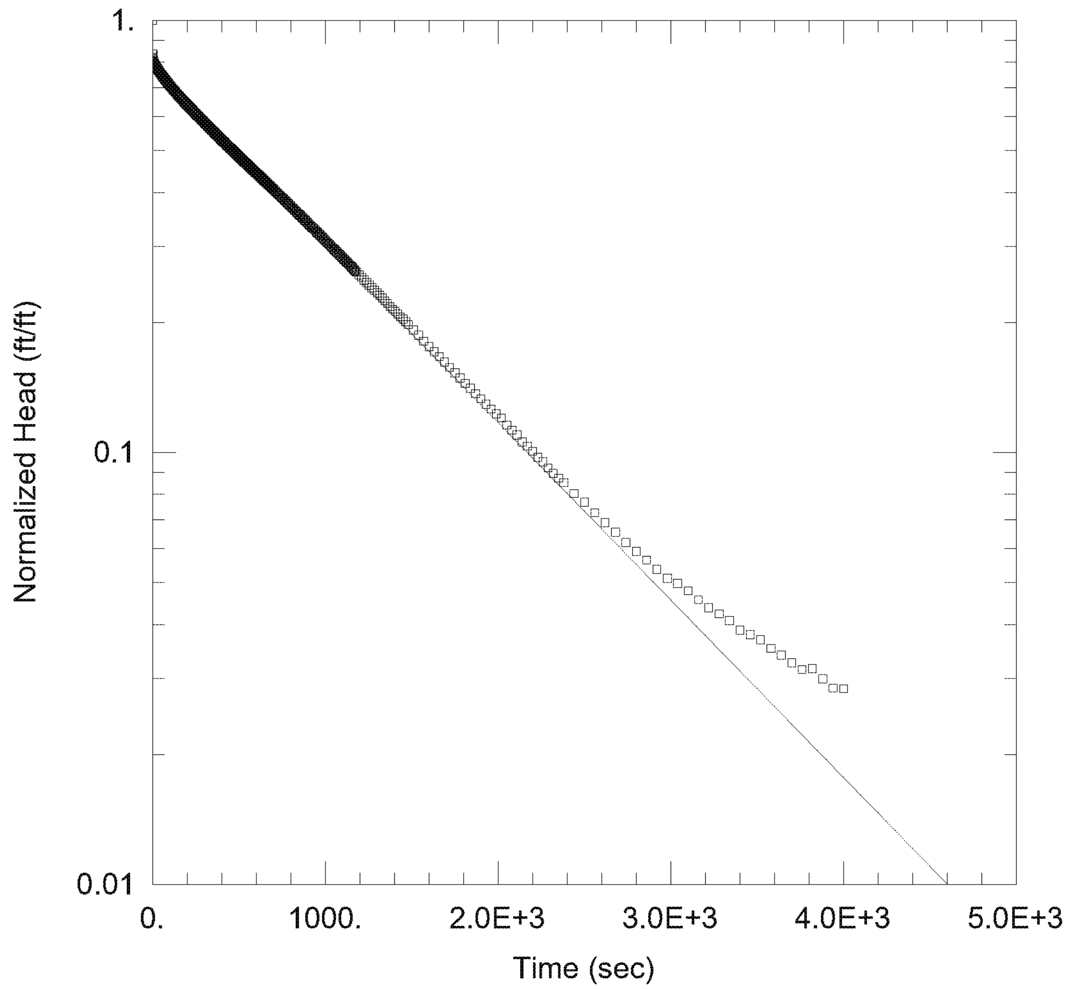
WELL DATA (CF-19-15D)

Initial Displacement: -3.748 ft
Total Well Penetration Depth: 72.07 ft
Casing Radius: 0.083 ft
Static Water Column Height: 53.91 ft
Screen Length: 10. ft
Well Radius: 0.083 ft
Gravel Pack Porosity: 0.

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice

K = 1.975E-6 ft/sec
y0 = -2.925 ft



CF-19-15D-OUT2

Data Set: \...\CF-19-15D-OUT2.aqt
Date: 05/31/19 Time: 14:13:52

PROJECT INFORMATION

Company: AGES, Inc.
Client: OVEC
Project: 2019042-07
Location: Clifty Creek
Test Well: CF-19-15D
Test Date: 4/16/2019

AQUIFER DATA

Saturated Thickness: 8. ft
Anisotropy Ratio (Kz/Kr): 1.

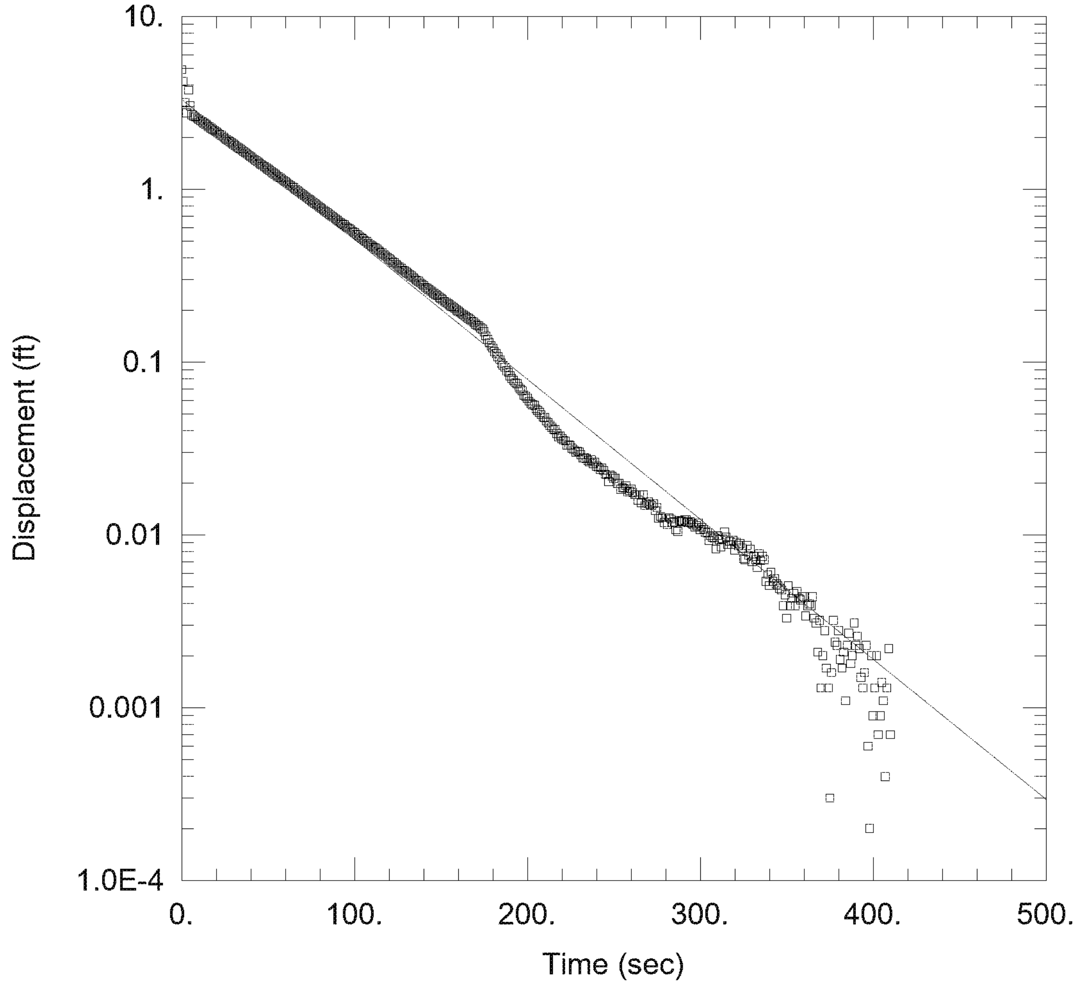
WELL DATA (CF-19-15D)

Initial Displacement: -3.748 ft
Total Well Penetration Depth: 72.07 ft
Casing Radius: 0.083 ft
Static Water Column Height: 53.91 ft
Screen Length: 10. ft
Well Radius: 0.083 ft
Gravel Pack Porosity: 0.

SOLUTION

Aquifer Model: Confined
Solution Method: Hvorslev

K = 2.158E-6 ft/sec
y0 = -2.925 ft



CF-19-15-IN1

Data Set: \...\CF-19-15-IN1.aqt
Date: 05/30/19 Time: 15:13:07

PROJECT INFORMATION

Company: AGES, Inc.
Client: OVEC
Project: 2019042-07
Location: Clifty Creek
Test Well: CF-19-15
Test Date: 4/16/2019

AQUIFER DATA

Saturated Thickness: 17.88 ft Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (CF-19-15)

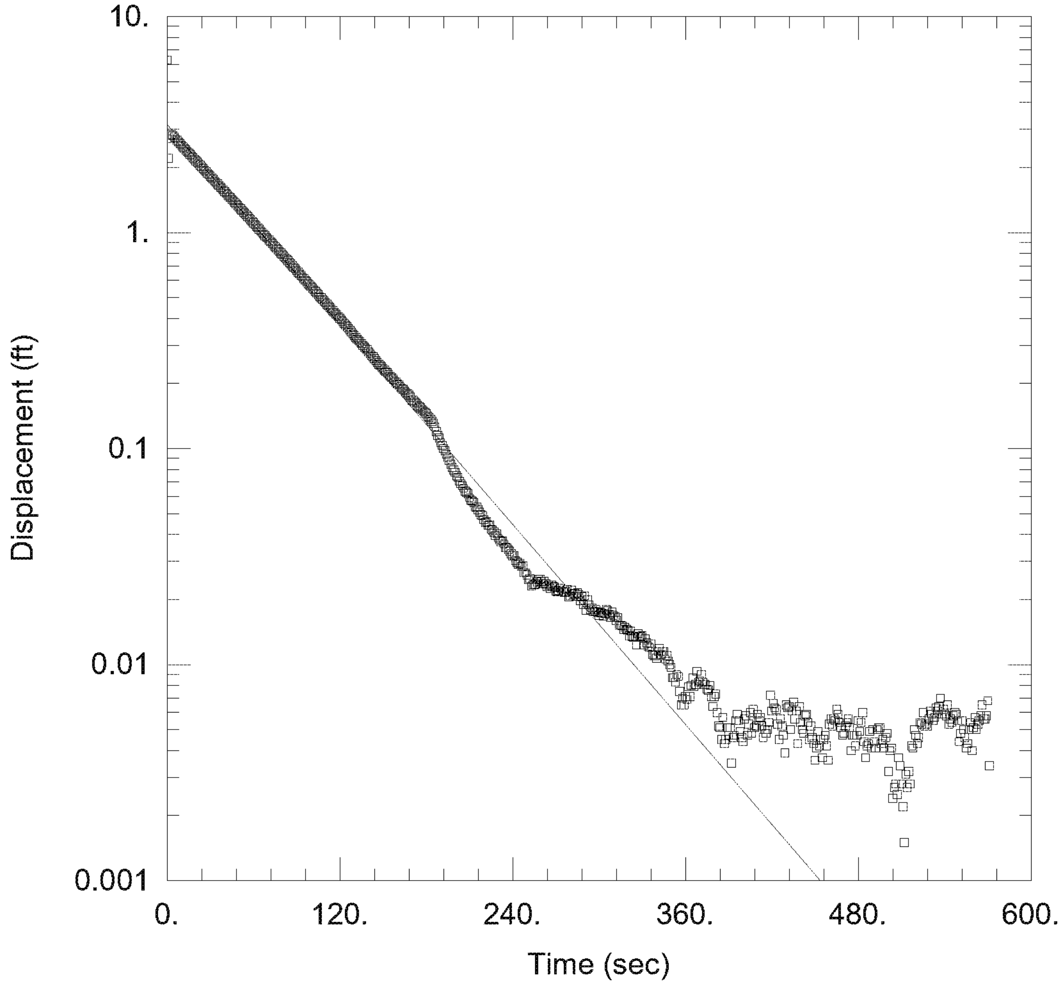
Initial Displacement: 4.937 ft
Total Well Penetration Depth: 35.91 ft
Casing Radius: 0.083 ft

Static Water Column Height: 17.88 ft
Screen Length: 10. ft
Well Radius: 0.083 ft
Gravel Pack Porosity: 0.

SOLUTION

Aquifer Model: Confined Solution Method: Bouwer-Rice

K = 2.89E-5 ft/sec y0 = 3.327 ft



CF-19-15-IN2

Data Set: \...\CF-19-15-IN2.aqt
Date: 05/30/19 Time: 15:43:33

PROJECT INFORMATION

Company: AGES, Inc.
Client: OVEC
Project: 2019042-07
Location: Clifty Creek
Test Well: CF-19-15
Test Date: 4/16/2019

AQUIFER DATA

Saturated Thickness: 17.88 ft Anisotropy Ratio (Kz/Kr): 1.

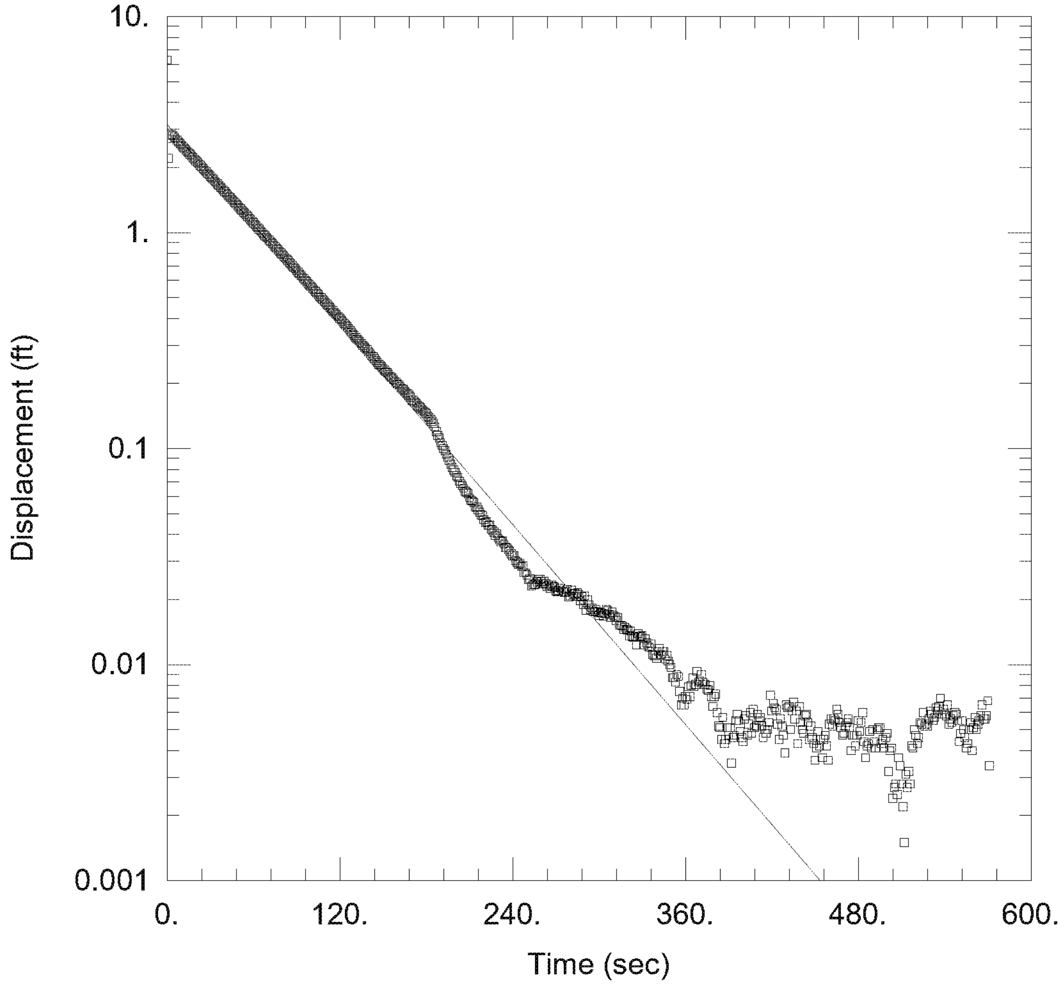
WELL DATA (CF-19-15)

Initial Displacement: 6.297 ft
Total Well Penetration Depth: 35.91 ft
Casing Radius: 0.083 ft
Static Water Column Height: 17.88 ft
Screen Length: 10. ft
Well Radius: 0.083 ft
Gravel Pack Porosity: 0.

SOLUTION

Aquifer Model: Confined Solution Method: Hvorslev

K = 3.356E-5 ft/sec y0 = 3.176 ft



CF-19-15-IN2

Data Set: \...\CF-19-15-IN2.aqt
Date: 05/31/19
Time: 13:41:24

PROJECT INFORMATION

Company: AGES, Inc.
Client: OVEC
Project: 2019042-07
Location: Clifty Creek
Test Well: CF-19-15
Test Date: 4/16/2019

AQUIFER DATA

Saturated Thickness: 17.88 ft
Anisotropy Ratio (Kz/Kr): 1.

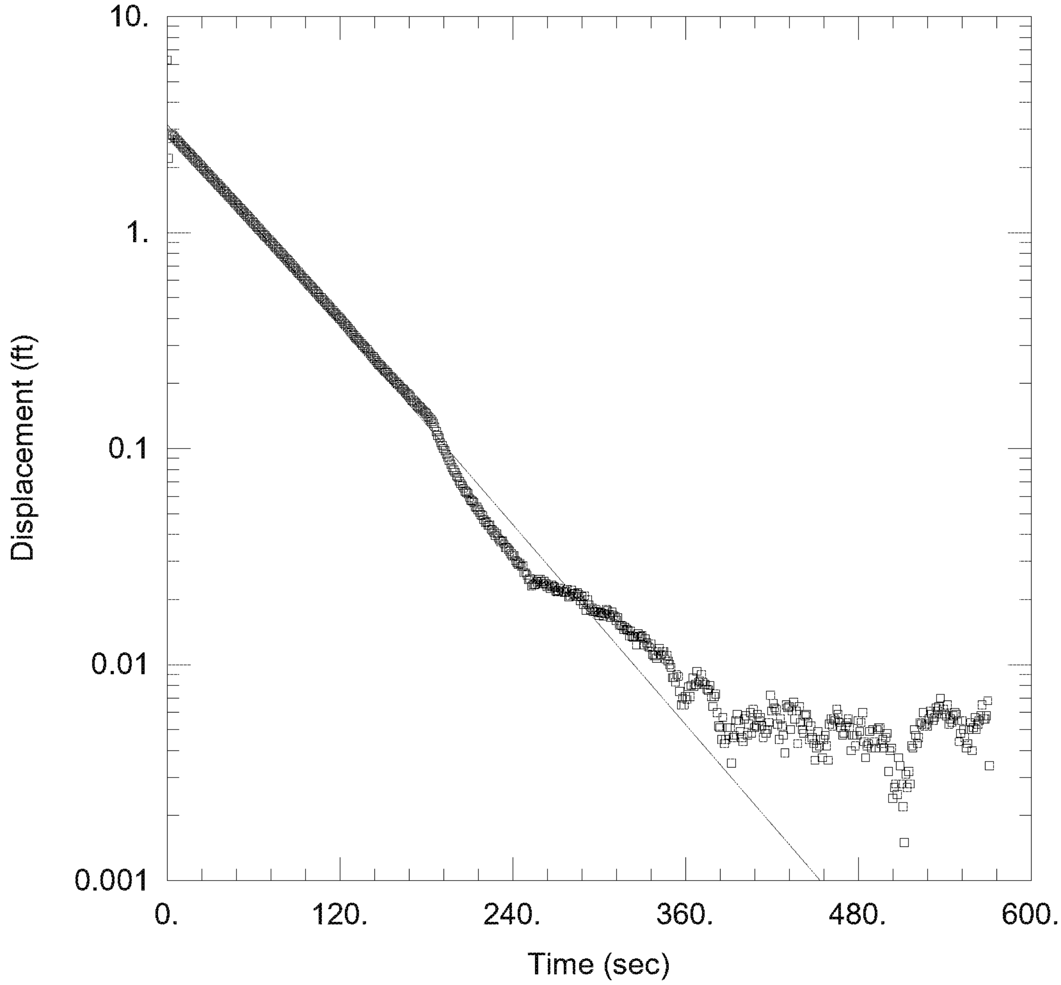
WELL DATA (CF-19-15)

Initial Displacement: 6.297 ft
Total Well Penetration Depth: 35.91 ft
Casing Radius: 0.083 ft
Static Water Column Height: 17.88 ft
Screen Length: 10. ft
Well Radius: 0.083 ft
Gravel Pack Porosity: 0.

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice

K = 2.753E-5 ft/sec
y0 = 3.177 ft



CF-19-15-IN2

Data Set: \...\CF-19-15-IN2.aqt
Date: 05/31/19
Time: 13:42:16

PROJECT INFORMATION

Company: AGES, Inc.
Client: OVEC
Project: 2019042-07
Location: Clifty Creek
Test Well: CF-19-15
Test Date: 4/16/2019

AQUIFER DATA

Saturated Thickness: 17.88 ft
Anisotropy Ratio (Kz/Kr): 1.

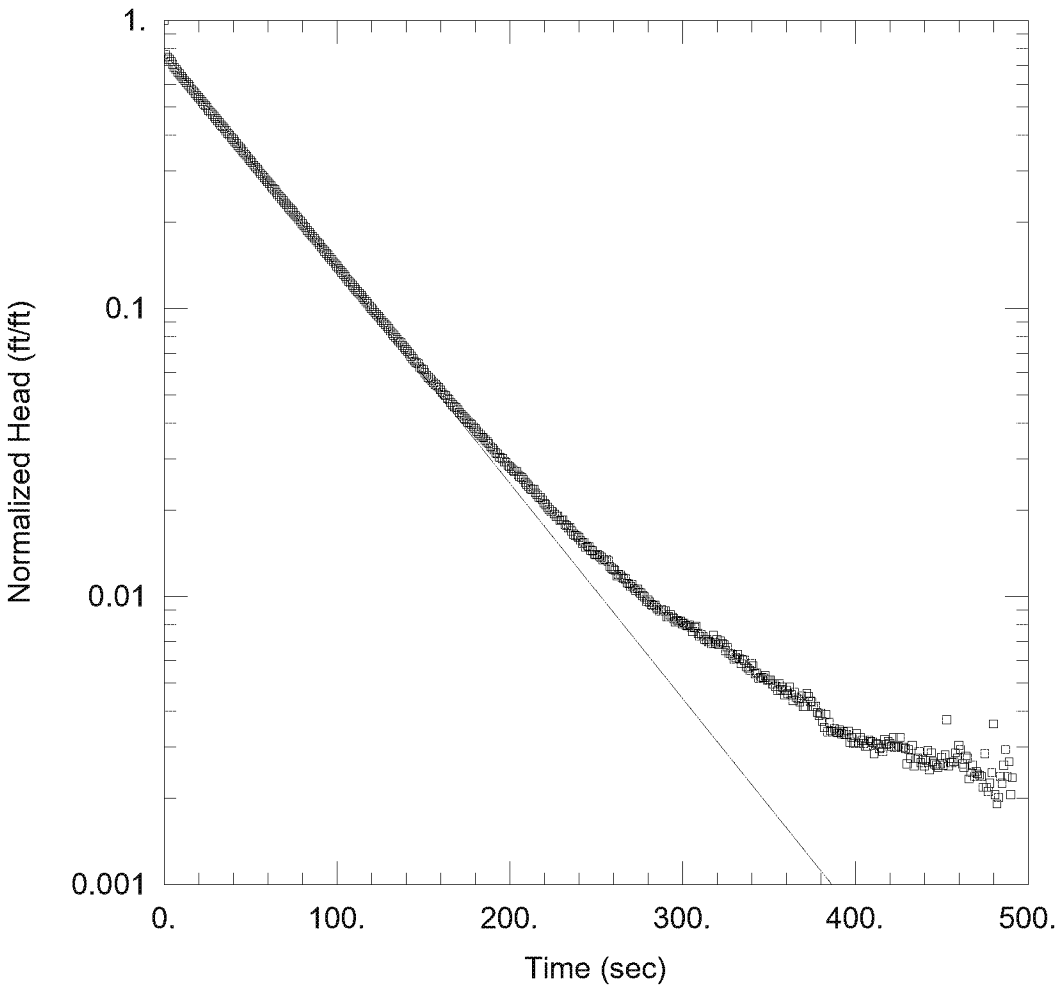
WELL DATA (CF-19-15)

Initial Displacement: 6.297 ft
Total Well Penetration Depth: 35.91 ft
Casing Radius: 0.083 ft
Static Water Column Height: 17.88 ft
Screen Length: 10. ft
Well Radius: 0.083 ft
Gravel Pack Porosity: 0.

SOLUTION

Aquifer Model: Confined
Solution Method: Hvorslev

K = 3.356E-5 ft/sec
y0 = 3.176 ft



CF-19-15-OUT1

Data Set: \...\CF-19-15-OUT1.aqt
Date: 05/31/19 Time: 13:45:04

PROJECT INFORMATION

Company: AGES, Inc.
Client: OVEC
Project: 2019042-07
Location: Clifty Creek
Test Well: CF-19-15
Test Date: 4/16/2019

AQUIFER DATA

Saturated Thickness: 17.88 ft Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (CF-19-15)

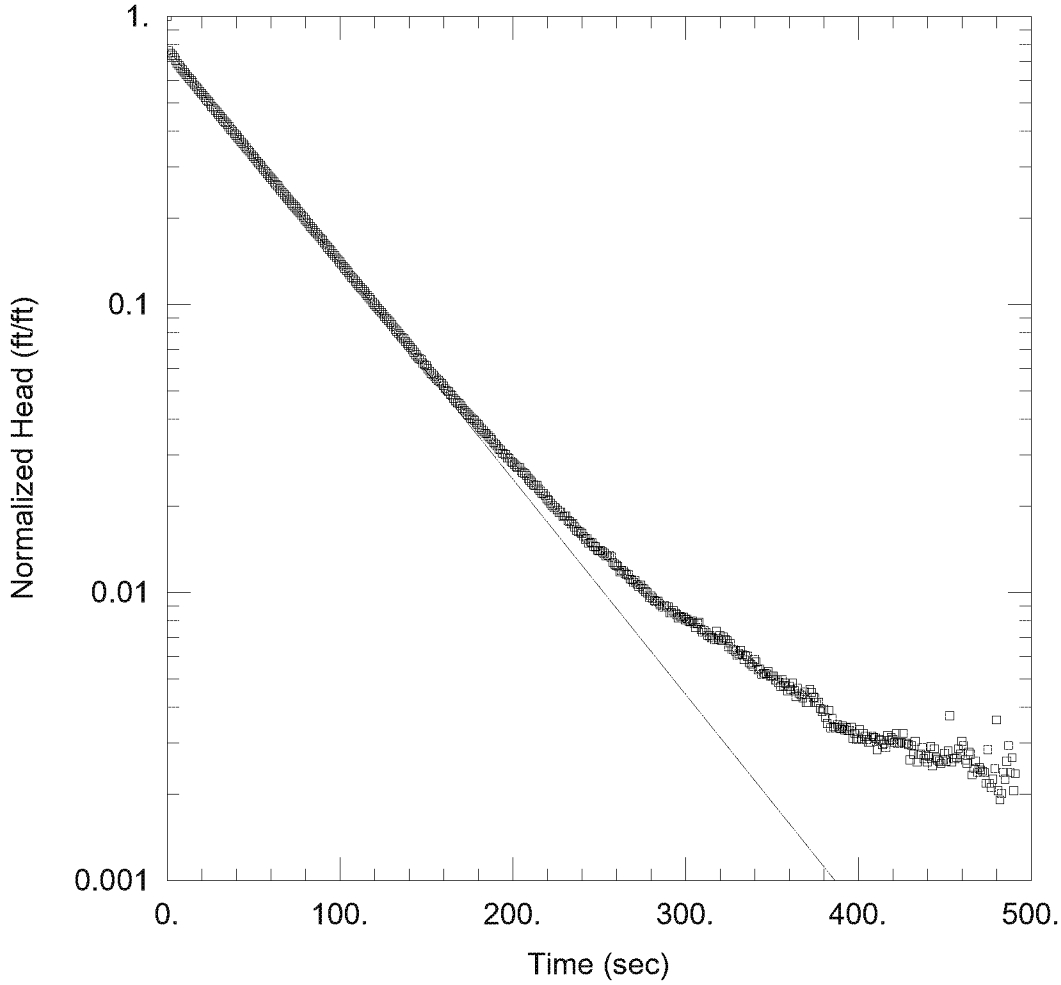
Initial Displacement: -4.041 ft
Total Well Penetration Depth: 35.91 ft
Casing Radius: 0.083 ft

Static Water Column Height: 17.88 ft
Screen Length: 10. ft
Well Radius: 0.083 ft
Gravel Pack Porosity: 0.

SOLUTION

Aquifer Model: Confined Solution Method: Bouwer-Rice

K = 2.667E-5 ft/sec y0 = -3.137 ft



CF-19-15-OUT1

Data Set: \...\CF-19-15-OUT1.aqt
Date: 05/31/19 Time: 13:46:00

PROJECT INFORMATION

Company: AGES, Inc.
Client: OVEC
Project: 2019042-07
Location: Clifty Creek
Test Well: CF-19-15
Test Date: 4/16/2019

AQUIFER DATA

Saturated Thickness: 17.88 ft
Anisotropy Ratio (Kz/Kr): 1.

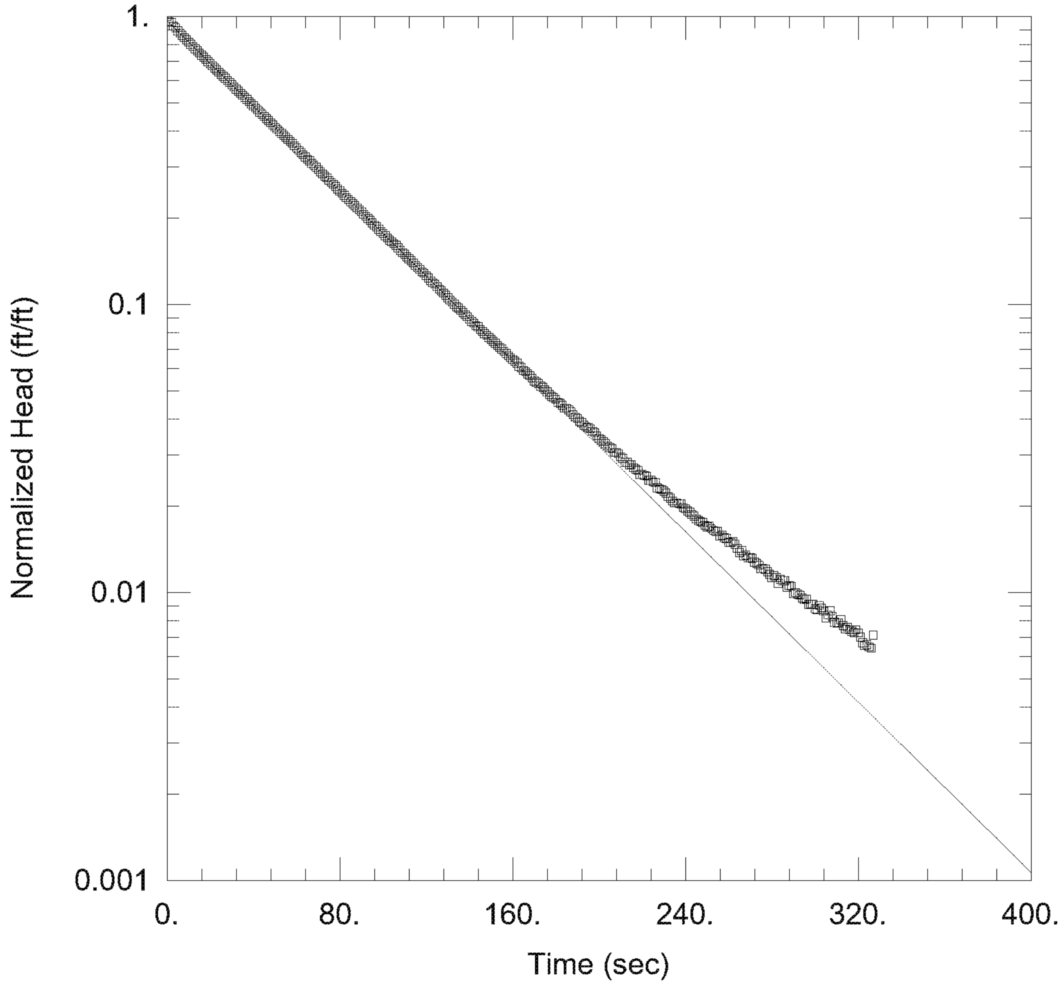
WELL DATA (CF-19-15)

Initial Displacement: -4.041 ft
Total Well Penetration Depth: 35.91 ft
Casing Radius: 0.083 ft
Static Water Column Height: 17.88 ft
Screen Length: 10. ft
Well Radius: 0.083 ft
Gravel Pack Porosity: 0.

SOLUTION

Aquifer Model: Confined
Solution Method: Hvorslev

K = 3.251E-5 ft/sec
y0 = -3.137 ft



CF-19-15-OUT2

Data Set: \...\CF-19-15-OUT2.aqt
Date: 05/31/19
Time: 13:48:21

PROJECT INFORMATION

Company: AGES, Inc.
Client: OVEC
Project: 2019042-07
Location: Clifty Creek
Test Well: CF-19-15
Test Date: 4/16/2019

AQUIFER DATA

Saturated Thickness: 17.88 ft
Anisotropy Ratio (Kz/Kr): 1.

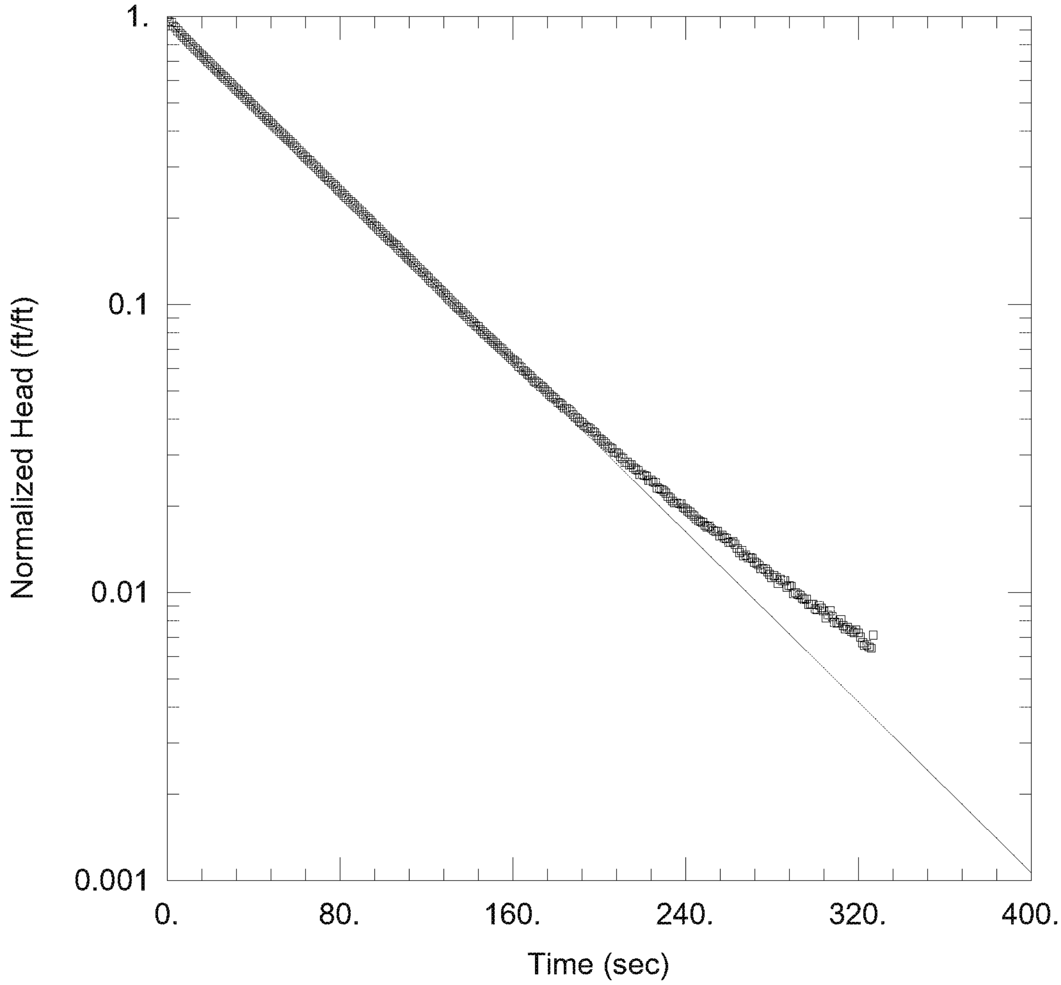
WELL DATA (CF-19-15)

Initial Displacement: -3.123 ft
Total Well Penetration Depth: 35.91 ft
Casing Radius: 0.083 ft
Static Water Column Height: 17.88 ft
Screen Length: 10. ft
Well Radius: 0.083 ft
Gravel Pack Porosity: 0.

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice

K = 2.637E-5 ft/sec
y0 = -3.027 ft



CF-19-15-OUT2

Data Set: \...\CF-19-15-OUT2.aqt
Date: 05/31/19 Time: 13:49:06

PROJECT INFORMATION

Company: AGES, Inc.
Client: OVEC
Project: 2019042-07
Location: Clifty Creek
Test Well: CF-19-15
Test Date: 4/16/2019

AQUIFER DATA

Saturated Thickness: 17.88 ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (CF-19-15)

Initial Displacement: -3.123 ft
Static Water Column Height: 17.88 ft
Total Well Penetration Depth: 35.91 ft
Screen Length: 10. ft
Casing Radius: 0.083 ft
Well Radius: 0.083 ft
Gravel Pack Porosity: 0.

SOLUTION

Aquifer Model: Confined
Solution Method: Hvorslev

K = 3.215E-5 ft/sec
y0 = -3.027 ft

APPENDIX E6 – 2020 SEMI-ANNUAL SELECTION OF REMEDY PROGRESS REPORT (LRCP)

OVEC/IKEC

INDIANA-KENTUCKY ELECTRIC CORPORATION
3932 U. S. Route 23
P. O. Box 468
Piketon, Ohio 45661
740-289-7200

WRITER'S DIRECT DIAL NO:
740-897-7768

June 1, 2020

CERTIFIED MAIL
RETURN RECEIPT REQUESTED

Mr. Bruno Pigott, Commissioner
Indiana Department of Environmental Management
100 N. Senate Avenue
Mail Code 50-01
Indianapolis, IN 46204-2251

Dear Mr. Pigott:

Re: Indiana-Kentucky Electric Corporation
2020 Semi-Annual Selection of Remedy Report

As required by 40 CFR 257.106(h)(9), the Indiana-Kentucky Electric Corporation is providing notification to the Commissioner of the Indiana Department of Environmental Management that the first Semi-Annual Selection of Remedy report has been completed in compliance with 40 CFR 257.97(a) for Clifty Creek Station's Landfill Runoff Collection Pond (LRCP). The intent of the report is to provide a six-month update on the progress of selecting a remedy for confirmed Appendix IV SSIs above the groundwater protection standard in the groundwater at the LRCP. The report has been placed in the facility's operating record in accordance with 40 CFR 257.105(h)(12), as well as, on the company's publicly accessible internet site in accordance with 40 CFR 257.107(h)(9), which can be viewed at https://www.ovec.com/CCRCompliance.php .

If you have any questions, or require any additional information, please call me at (740) 897-7768.

Sincerely,

Tim Fulk

Tim Fulk
Engineer II

TLF:klr

Semiannual Report on the Progress of Remedy Selection

40 CFR 257.97(a)

Landfill Run-off Collection Pond

Clifty Creek Station

Madison, Indiana

May 2020

Prepared by: Indiana-Kentucky Electric Corporation

3932 U.S. Route 23

Piketon, OH 45661

OVEC IKEC

Ohio Valley Electric Corporation / Indiana-Kentucky Electric Corporation

TABLE OF CONTENTS

1 INTRODUCTION

In accordance with 40 CFR § 257.97(a), the Indiana-Kentucky Electric Corporation (IKEC) has prepared this Semi-Annual report to document progress toward remedy selection, design and implementation of corrective actions associated with groundwater monitoring exceedances at the Clifty Creek Station's Landfill Runoff Collection Pond (LRCP). This report summarizes activities during the period of December 7, 2019, through June 7, 2020. Updates to the report will be published semi-annually, until such time a remedy has been selected. Upon selection, a final report will be prepared describing the selected remedy and how it meets the standards specified in the rule.

1.1 REGULATORY BACKGROUND

On December 19, 2014, the United States Environmental Protection Agency (U.S. EPA) issued their final Coal Combustion Residuals (CCR) regulation which regulates CCR as a non-hazardous waste under Subtitle D of Resource Conservation and Recovery Act (RCRA) and became effective six (6) months from the date of its publication (April 17, 2015) in the Federal Register, referred to as the "CCR Rule." The rule applies to new and existing landfills, and surface impoundments used to dispose of or otherwise manage CCR generated by electric utilities and independent power producers. The rule includes requirements for monitoring groundwater and assessing corrective measures if constituents listed in Appendix IV of the rule are detected in groundwater samples collected from downgradient monitoring wells at Statistically Significant Levels (SSL) greater than the established GWPS.

In May 2019, IKEC initiated an Assessment of Corrective (ACM) measures at the Clifty Creek LRCP as a result of a confirmed SSL of Appendix IV constituent Molybdenum in monitoring wells CC-15-08 and CC-15-09 during September 2018 Assessment Monitoring Activities, as required by 40 CFR § 257.97(a). An additional SSL for constituent Boron was also confirmed, but an Alternative Source Demonstration was pursued and determined to be successful. In accordance with 40 CFR § 257.96(a), IKEC prepared an ACM report for the Clifty Creek LRCP. It was placed it in the facility's operating record and uploaded to IKEC's Publicly Accessible Internet Site on September 19, 2019. The ACM Report provided an assessment of the effectiveness of potential corrective measures in achieving the criteria provided in 40 CFR § 257.96(c). Multiple strategies were evaluated to address groundwater exhibiting concentrations of Molybdenum above the GWPS, with two technically feasible options identified. Both feasible options require the removal of free water from the pond, followed by the execution of an engineered cap and closure of the LRCP facility, and are as follows:

- Monitored Natural Attenuation (MNA); and
- Conventional Vertical Well System (Groundwater Extraction and Treatment) (Ex-Situ)

Following the completion of the ACM Report, IKEC hosted a public meeting to present the options for remediation on November 7, 2019, in Madison, Indiana. IKEC then observed a 30-day public comment period, per 40 CFR § 257.97(a), prior to beginning the process of selecting a remedy. No comments were received during this time period.

Semi-annual reports are required pursuant to 40 CFR § 257.97(a) to document progress toward remedy selection and design. The CCR Rule provides flexibility for more field investigation, data analysis and consideration prior to the selection of a remedy. IKEC will continue to review new data as it becomes available and implement changes to the groundwater monitoring and corrective action program as necessary to maintain compliance with the rule.

1.2 Report Contents

The first semi-annual progress report provides regulatory background, an overview of site characteristics and ACM findings, and summarizes activities supporting the selection and implementation of a remedy during the period of December 7, 2019, through June 7, 2020.

2 Site Background

The Clifty Creek Station, located in Madison, Indiana, is a 1.3-gigawatt coal-fired generating plant operated by IKEC, a subsidiary of the Ohio Valley Electric Corporation (OVEC). The Clifty Creek Station has six (6) 217.26-MW generating units and has been in operation since 1955. Ash products were sluiced to disposal ponds located in the plant site since it began operation. During the course of plant operations, CCRs have been managed and disposed of in various units at the station. The Type I Landfill and LRCP occupy an approximately 200-acre area situated within an eroded bedrock channel. To allow for more disposal capacity, an on-site fly ash pond was developed into a Type III Landfill in 1988. All required permits for the Type III Landfill were obtained from the Indiana Department of Environmental Management (IDEM) and the Type III Landfill went operational in 1991. In March 1994, IDEM approved a pH variance for the disposal of low-sulfur coal ash in the fly ash Type III Landfill. Emplacement of low-sulfur coal ash in the Type III Landfill began in January 1995. In April 2007, IKEC submitted a permit application to IDEM to upgrade the former Type III landfill to a Type I landfill. In 2013, IDEM issued a renewed permit and approved IKEC's request to upgrade the landfill to a Type I landfill.

The Type I Landfill consists of approximately 109 acres, and has been approved by IDEM as a Type I Residual Waste Landfill. The remaining 91 acres consist of the LRCP located at the southwest end of the Type I Landfill. The Type I Landfill and the LRCP occupy an approximately 200-acre area situated within an eroded bedrock channel.

2.1 Unit Specific Geology and Hydrogeology

Bedrock beneath the LRCP consists of impermeable limestone and shale of the Ordovician Dillsboro formation, which is overlain by approximately 20 feet of clayey gravel with sand (Applied Geology and Environmental Science, Inc. [AGES] 2018a). The clayey gravel with sand is overlain by a lean clay with sand, which is overlain by a fine to medium sand with gravel, silt and clay. The uppermost unit in the area is a surficial layer of silty clay. A limestone ridge known as the Devil's Backbone runs northeast to southwest along the length of the Type I Landfill & LRCP. The Devil's Backbone acts as an impermeable barrier that forces groundwater passing beneath the Type I Landfill to flow either toward the northeast or toward the southwest.

Based on historic aquifer testing conducted at the site, the upper lean clay deposits exhibit low permeability, do not yield adequate quantities of water to wells, and are considered to be an aquitard. The underlying fine-medium sand with silt is considered to be an unconfined or possibly semi-confined aquifer and is therefore designated as the uppermost aquifer at the LRCP (AGES, 2018).

2.2 Potential Receptor Review

IKEC completed an assessment of the proximity of public and private drinking water supplies to the LRCP in response to SSLs above the GWPS. It was determined that the withdrawal wells designated by the Indiana Department of Natural Resources (IDNR) as drinking water wells within a one-mile radius were not hydraulically connected to the groundwater at the LRCP facility or are located upgradient from the facility.

3 Groundwater Assessment Monitoring Program

Groundwater assessment monitoring for the Clifty Creek LRCP is conducted in accordance with 40 CFR § 257.95.

3.1 Groundwater Monitoring Well Network

In compliance with 40 CFR § 257.91, the CCR groundwater monitoring network for the LRCP consists of the following eight (8) wells:

- CF-15-04 (Background);
- CF-15-05 (Background);
- CF-15-06 (Background);
- CF-15-07 (Downgradient);
- CF-15-08 (Downgradient);
- CF-15-09 (Downgradient);
- WBSP-15-01 (Background); and
- WBSP-15-02 (Background).

Additionally, four (4) monitoring wells that were installed as part of the additional assessment activities for the LRCP were added to the CCR groundwater monitoring network for the LRCP as follows:

- CC-19-08D (Downgradient);
- CC-19-14 (Downgradient);
- CC-19-15 (Downgradient); and
- CC-19-15D (Downgradient).

3.2 Type I Landfill Alternative Source Demonstration

The Type I Landfill and LRCP share a common monitoring network. Due to this fact, upon verification of an exceedance above the GWPS, an Alternative Source Demonstration was pursued. Based on a review of current and historic data, the Type I Landfill was not believed to be the source of Boron in groundwater in the area. An ASD was completed in general accordance with guidelines presented in the *Solid Waste Disposal Facility Criteria Technical Manual* (U.S. EPA 1993). It was concluded that the Type I Landfill was not the source of Boron detected in the area. This conclusion was supported by the following evidence:

- "Foundation soils" that extend from beneath the LRCP and the hydraulically placed fly ash southwest to the Ohio River provide a direct hydraulic connection between the historic hydraulically placed fly ash and the CCR groundwater monitoring wells CF-15-08 and CF-15-09.
- Historic data from the IDEM groundwater monitoring program indicate that Boron concentrations similar to those observed in CCR wells CF-15-08 and CF-15-09 were detected in IDEM wells CF-9406 and CF-9407 for 17 years prior to operation of the Type I Landfill, indicating that the Boron is associated with the historic hydraulically placed fly ash.
- Using the previously calculated groundwater flow velocity of 45 feet per year (ft/yr), it is estimated that it would take 120 years for groundwater flowing beneath the Type I Landfill to reach the CCR monitoring wells.

The ASD Report for the March 2018 Detection Monitoring Event (AGES 2019b) was completed in June 2019, and was certified on July 3, 2019. Based on the successful ASD, an ACM was not required at the Type I Landfill. By definition of the CCR Rule, the LRCP is unlined and the historic hydraulically placed fly ash extends beneath the LCRP to the embankment; therefore, an ACM was conducted at the LRCP.

3.3 Groundwater Characterization

Groundwater assessment monitoring was first conducted at the Clifty Creek LRCP during September 2018 sampling. Molybdenum, an Appendix IV constituent, was detected and confirmed to exceed the GWPS of 100 µg/L at wells CC-15-08 and CC-

15-09. In response, IKEC was required to characterize the extent of the release, pursuant to 40 CFR § 257.95(g)(1), and installed additional monitoring wells at the property boundary (wells CC-19-08D, CC-19-14, CC-19-15, and CC-19-15D). It was determined that Molybdenum was not leaving the property at levels higher than the GWPS, and therefore the potential remediation zone was confined to the LRCP complex (AGES, 2019).

4 ASSESSMENT OF CORRECTIVE MEASURES

In accordance with 40 CFR § 257.96(a), IKEC prepared an ACM report for the Clifty Creek LRCP and placed it in the facility's operating record as well as uploaded it to the IKEC's Publicly Accessible Internet Site on September 19, 2019. The ACM Report provided an assessment of the effectiveness of potential corrective measures in achieving the criteria provided in 40 CFR § 257.96(c).

4.1 PLANNED SOURCE CONTROL MEASURES

Per 40 CFR § 257.96(a), the objectives of the corrective measures evaluated in this ACM Report are "to prevent further releases, to remediate any releases, and to restore affected area to original conditions." As required in 40 CFR § 257.97(b), corrective measures, at minimum, must:

(1) Be protective of human health and the environment;

(2) Attain the groundwater protection standard as specified pursuant to § 257.95(h);

(2) Control the source(s) of releases so as to reduce or eliminate, to the maximum extent feasible, further releases of constituents in Appendix IV to this part into the environment;

(3) Remove from the environment as much of the contaminated material that was released from the CCR unit as is feasible, taking into account factors such as avoiding inappropriate disturbance of sensitive ecosystems;

(5) Comply with standards for management of wastes as specified in § 257.98(d).

During the ACM development process, several in-situ and ex-situ remedial technologies were evaluated to address Molybdenum in groundwater at the LRCP, and screened against evaluation criteria requirements in 40 CFR § 257.96(c). The two (2) technologies that appear to be most technically feasible, and therefore most likely for selection as a remedy are:

- Monitored Natural Attenuation; and
- Conventional Vertical Well System (Groundwater Extraction) (Ex-Situ).

Both feasible options require removal of free water from the pond, followed by the execution of an engineered cap and closure of the LRCP facility. IKEC is committed to continued compliance with the requirements and timeframes of the CCR Rule, and will close the Clifty LRCP in accordance with 40 CFR § 257.102 prior to implementation of further groundwater remediation measures. Construction efforts for LRCP closure cannot proceed until such time IKEC can design and construct controls to redirect a significant volume of offsite stormwater around the LRCP, develops a closure plan and receives approval from Indiana Department of Environmental Management to proceed. IKEC is presently working with the site's Qualified Professional Engineer to develop the designs in advance of preparing the applicable permitting package.

The initial closure methods described above will reduce the potential for releases and migration of CCR constituents. Groundwater assessment monitoring as required by 40 CFR § 257.96(b) will continue until a remedy is selected and implemented. The monitoring will be conducted to track changes in groundwater conditions as a result of these closures and operational changes. These data will also be considered in the selection and design of a remedy in accordance with 40 CFR § 257.97.

4.2 POTENTIAL REMEDIAL TECHNOLOGIES

As a source control measure, the Clifty Creek LRCP will be closed in accordance with CFR § 257.102 prior to implementation of further groundwater remediation efforts. In addition to source control measures, two primary strategies were identified to address groundwater exhibiting concentrations of Molybdenum above the GWPS, including:

- Monitored Natural Attenuation; and
- Conventional Vertical Well System (Groundwater Extraction) (Ex-Situ).

The ACM report titled "Clifty Creek LRCP- Assessment of Corrective Measures Report", (AGES, 2019), which is available on IKEC's publicly accessible internet site, provides a more detailed description of these corrective measures. The effectiveness of each potential corrective measure was assessed in accordance with 40 CFR § 257.96 (c). Both options listed above are considered technically feasible, and appropriate for groundwater remediation efforts at the LRCP.

5 SELECTION OF REMEDY: CURRENT PROGRESS

As noted in the ACM Report, IKEC determined that source control would be best achieved by leaving the CCR material in place and installing a CCR compliant cap system.

During the period covered by this semi-annual report, IKEC evaluated the construction duration and constraints associated with closure in place. A preliminary cost estimate and project schedule has been developed for this portion of corrective measure activities.

IKEC's hydrogeologist conducted the semi-annual groundwater sampling and testing during this report period. In addition to sampling the monitoring wells in the CCR groundwater monitoring network, the sentinel wells installed to aid in ACM activities were also sampled. A total of 11 wells (8 Network and 3 Sentinel) were sampled near the LRCP and the results summarized in the report, "2019 – Clifty Creek CCR Annual Groundwater Monitoring and Corrective Action Report, (AGES, 2019)"

5.1 PLANNED WORK

IKEC's consultant or hydrogeologist will sample and test all of the monitoring wells as part of the semi-annual requirement.

IKEC will develop a closure plan for the LRCP, and submit to Indiana Department of Environmental Management for approval prior to proceeding with closure efforts.

IKEC and their CCR hydrogeologist will continue to evaluate the technology options identified in the ACM, and engage the site's Qualified Professional Engineer to ensure the alternatives meet the criteria set forth in 40 CFR 257.97.

IKEC will submit the next progress report by December 6, 2020.

A final report will be prepared after the remedy is selected. This report will describe the proposed solution and how it meets the standards specified in 40 CFR § 257.97(b) and 257.97(c). Recordkeeping requirements specified in 40 CFR § 257.105(h), notification requirements specified in 40 CFR § 257.106(h), and internet requirements specified in 40 CFR § 257.107(h) will be complied with as required by 40 CFR § 257.96(f).

APPENDIX E7 – STRUCTURAL STABILITY ASSESSMENT

Stantec Consulting Services Inc.
11687 Lebanon Road, Cincinnati OH 45241

October 17, 2016
File: 175534018
Revision 0

Indiana-Kentucky Electric Corporation
3932 U.S. Route 23
P.O. Box 468
Piketon, Ohio 45661

RE: Initial Structural Stability Assessment
Landfill Runoff Collection Pond
EPA Final Coal Combustion Residuals (CCR) Rule
Clifty Creek Station
Madison, Jefferson County, Indiana

1.0 PURPOSE

This letter documents Stantec's certification of the initial structural stability assessment for the Indiana-Kentucky Electric Corporation (IKEC) Clifty Creek Station's Landfill Runoff Collection Pond. Based on this assessment, the Landfill Runoff Collection Pond is in compliance with the structural stability requirements in the EPA Final CCR Rule at 40 CFR 257.73(d).

2.0 INITIAL STRUCTURAL STABILITY ASSESSMENT

As described in 40 CFR 257.73(d), documentation is required on how the Landfill Runoff Collection Pond has been designed, constructed, operated, and maintained according to the structural stability requirements listed in the section. The combined capacity of all spillways must also be designed, constructed, operated, and maintained to adequately manage flow from the 1,000-year storm event based upon a hazard potential classification of "significant."

3.0 SUMMARY OF FINDINGS

The attached report presents the initial structural stability assessment of the Landfill Runoff Collection Pond. The results show that the impoundment meets the structural stability requirements set forth in 40 CFR 257.73(d)(1)-(2).

4.0 QUALIFIED PROFESSIONAL ENGINEER CERTIFICATION

I, Stan A. Harris, being a Professional Engineer in good standing in the State of Indiana, do hereby certify, to the best of my knowledge, information, and belief:

1. that the information contained in this certification is prepared in accordance with the accepted practice of engineering;

Re: **Initial Structural Stability Assessment**
Landfill Runoff Collection Pond
EPA Final Coal Combustion Residuals (CCR) Rule
Clifty Creek Station
Madison, Jefferson County, Indiana

2. that the information contained herein is accurate as of the date of my signature below; and

3. that the initial structural stability assessment for the IKEC Clifty Creek Station's Landfill Runoff Collection Pond meets the requirements specified in 40 CFR 257.73(d)(1)-(2).

SIGNATURE _______________ DATE 10/17/16

ADDRESS: Stantec Consulting Services Inc.
11687 Lebanon Road
Cincinnati, Ohio 45241

TELEPHONE: (513) 842-8200

ATTACHMENTS: Clifty Creek Landfill Runoff Collection Pond Initial Structural Stability Assessment Report

STAN A. HARRIS
REGISTERED
No. PE-19700150
STATE OF
INDIANA
PROFESSIONAL ENGINEER
10/17/16

Initial Structural Stability Assessment

Clifty Creek Station
Landfill Runoff Collection Pond
Madison, Jefferson County, Indiana

Prepared for:
Indiana-Kentucky Electric Corporation
Piketon, Ohio

Prepared by:
Stantec Consulting Services Inc.
Cincinnati, Ohio

October 17, 2016

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1.0 PROJECT BACKGROUND

On April 17, 2015 the "Disposal of Coal Combustion Residuals (CCR) from Electric Utilities" (EPA Final CCR Rule) was published in the Federal Register. Stantec Consulting Services, Inc. (Stantec) was contracted by the Indiana-Kentucky Electric Corporation (IKEC) to analyze the structural stability of the Clifty Creek Station's Landfill Runoff Collection Pond (LRCP) and evaluate its compliance with §257.73 of the EPA Final CCR Rule.

As required by §257.73 of the EPA Final CCR Rule, an initial structural integrity evaluation is required by October 17, 2016 and must include an initial structural stability assessment for each existing CCR surface impoundment that meets the conditions of paragraph (b) as follows:

1. Has a height of five feet or more and a storage volume of 20 acre-feet or more, or
2. Has a height of 20 feet or more.

2.0 UNIT DESCRIPTION

The Clifty Creek Station is located on the north shore of the Ohio River downstream of Madison, Indiana. The station consists of six coal-fired electric generating units, each nominally rated at 217 megawatts. The Clifty Creek Station is directly accessible from State Route 56. A plan view of the station is included in Appendix A.

The Landfill Runoff Collection Pond is located at the southern edge of the station. It is bordered by the station's coal combustion residuals (CCR) landfill to the north, natural grade to the east and west, and by a dam to the south that runs along the bank of the Ohio River. Approximately 508 acres of both landfill contact water and stormwater runoff drain to the Landfill Runoff Collection Pond. Upon the completion of the CCR landfill, the area draining to the Landfill Runoff Collection Pond will be reduced to approximately 443 acres (Stantec, 2016b).

The subsections under §257.73(d) address conditions of appurtenances categorized as embankments, spillways, or hydraulic structures. Sections 2.1 to 2.3 below provide descriptions of the individual unit elements that fall within these appurtenance categories. Appendix A provides an overview of the Clifty Creek Station and the Landfill Runoff Collection Pond.

Note that all elevations included in this document and appendices are referenced to the North American Vertical Datum of 1988 (NAVD 88).

2.1 EMBANKMENTS

2.1.1 LRCP Dam

The LRCP Dam forms the southern boundary for the pond, approximately 700 feet from the Ohio River. It is an earthen dam with a crest length roughly 1,600 feet and a maximum height of 70 feet. The minimum dam crest elevation is 502.9 feet mean sea level (MSL) with a maximum of 505.9 feet along the left abutment (GZA, 2009). The LRCP Dam is registered with the Indiana Department of Natural Resources (IDNR) as Dam No. 39-12.

The LRCP Dam consists of the main 70-foot high dam, a 25-foot high dike on top of an adjoining ridge, a natural rock ridge, and a 15-foot high saddle dike between the rock ridge and the east abutment (AEPSC, 1985). Figure 1 provides a sketch of the components of the LRCP Dam. The main dam has a constructed downstream slope of approximately 2.7H:1V above elevation 474 feet and 3.3H:1V below elevation 474 feet and an upstream slope of about 4.4H:1V. The saddle dike has a downstream slope of 2H:1V and a length of 250 feet (GZA, 2009).

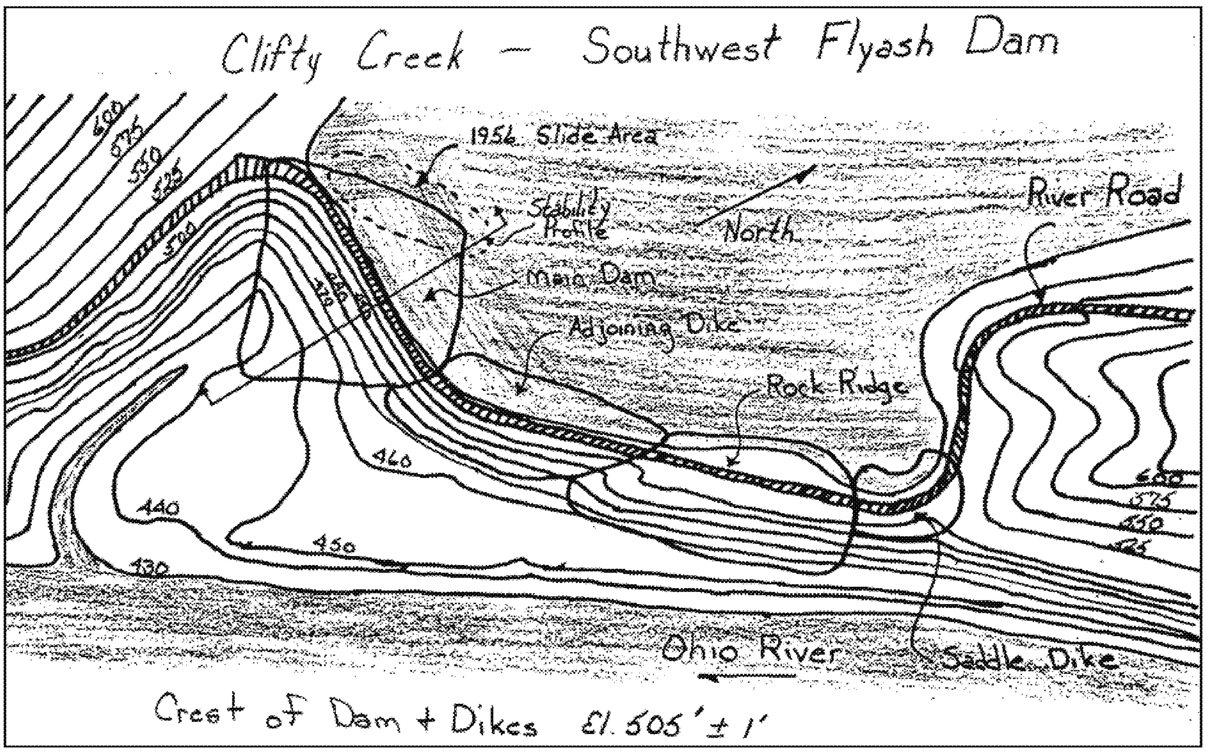

Figure 1 LRCP Dam Construction Detail *(AEPSC, 1985)*

2.2 SPILLWAYS

2.2.1 Primary Spillway System

The LRCP primary spillway is an inclined six-foot by three-foot reinforced concrete box culvert with a riser box structure containing grated inlets at 11-foot intervals in elevation. The inclined box is connected to a 400-foot long, 72-inch diameter concrete pipe that discharges to the Ohio River (Stantec, 2016b).

2.3 HYDRAULIC STRUCTURES

Other than the primary spillway described above, no hydraulic structures are located at the LRCP.

3.0 FOUNDATIONS AND ABUTMENTS (§257.73(d)(1)(i))

Per §257.73(d)(1)(i), the initial structural stability assessment must document whether the unit has been designed, constructed, operated, and maintained with stable foundations and abutments. The Landfill Runoff Collection Pond has the following features that fall within this requirement:

- LRCP Dam

Assessment of the foundations and abutments associated with these features was completed considering the following criteria related to the EPA Final CCR Rule:

- Review inspection reports of the facility, considering frequency of inspections, and if the inspections included review and/or assessment of features including cracking, settlement, deformation, or erosion of the foundations/abutments. Inspections should indicate that there are no significant signs of tension cracking, settlement, depressions, erosion, and/or deformations at the crest, slope, and toe of the structure.

- Confirm that an assessment of seepage conditions of the foundation, with considerations of heave and vertical exit gradient, has been performed. Verify that the seepage assessment follows appropriate methodologies (such as USACE EM 1110-2-1901) and that the foundations exhibit acceptable performance (e.g. FS for piping greater than or equal to 3.0).

3.1 LRCP DAM

3.1.1 Background

The LRCP Dam is an earthen dam tying into natural ground on both sides. Mapping of unconsolidated sediments indicate lowland areas adjacent to the Ohio River are predominantly underlain by clay, silt, sand, and gravel deposited as alluvium, lacustrine, and outwash deposits. Glacial deposits are Illinoian and Wisconsinan Quaternary age and belong to the Atherton Formation. Overlying alluvial deposits are Martinsville Formation. Bedrock underlying the site is of the Maquoketa Group, consisting of shale (about 80 percent) and limestone (about 20 percent) (Stantec, 2016a). Based on previous geotechnical studies (AEPSC, 1985 and Stantec, 2016a), the foundation of the LRCP Dam generally consists lean clay, silty sands with interbedded layers of silty clay with a rock ridge of limestone with layers of calcareous shale on the southwest side.

3.1.2 Assessment

A qualified person performs inspections of the Landfill Runoff Collection Pond weekly, monthly, quarterly, and annually. Regular site inspections have been conducted and documented for the Landfill Runoff Collection Pond from 1976 to 2016. These inspections include observations related to foundation and abutment conditions with respect to observable cracking, settlement, depressions, erosion, and deformation.

AEPSC (2015) noted no signs of new sloughing, depressions or areas of wetness and no seeps. A slip was being monitored near the left abutment, but appeared to have stabilized. The slip was thought to have no adverse effect on the integrity of the dam due to location and regrading of the area was discussed.

GZA (2009) observed no unusual movement and some shallow surficial erosion. The saddle dike exhibited shallows scarps on its 2H:1V slope, but the scarps were noted as healed and fully vegetated. Onsite discussions suggested that the scarps were a long-time condition and buttressing at the toe had been performed to attempt to mitigate further sloughing of the slope. This issue is noted in the previous inspections reports and continues to be monitored.

Seepage analysis for the original dike construction is not available. A letter from the design engineer to the owner states that the dam is constructed of relatively impervious material on a foundation of impervious material with the limited exposure to the high river stages. Special measures against seepage through and beneath the dikes were not required (A. Casagrande et al, 1952).

As part of the geotechnical exploration in 2009, a seepage analysis was conducted using SEEP/W (Stantec, 2010). This module is part of the GeoStudio 2007, Version 7.23 software package developed by GEO-SLOPE International, Ltd. of Calgary, Alberta, Canada (GEO-SLOPE International, Ltd, 2007). This package also includes SLOPE/W module for slope stability analysis.

The seepage analysis indicated that the factor of safety for piping/heave was 3.0 or greater for the LRCP Dam.

3.1.3 Conclusion

Based on the assessment of the foundation and abutments for the LRCP Dam, the EPA Final CCR Rule-related criteria listed above have been met.

4.0 SLOPE PROTECTION (§257.73(d)(1)(ii))

Per §257.73(d)(1)(ii), the initial structural stability assessment must document whether the unit has been designed, constructed, operated, and maintained with adequate slope protection to protect against surface erosion, wave action, and adverse effects of sudden drawdown. The Landfill Runoff Collection Pond has the following features that fall within this requirement:

- LRCP Dam

Assessment of the slope protection associated with these features was completed considering the following criteria related to the EPA Final CCR Rule:

1. *Regular (weekly) inspections for erosion. Inspections should show there are no significant signs of deterioration in the slope protection configuration of the Item.*

2. *Appropriate slope protection shall be provided based on anticipated flow velocities. [Hydrologic/hydraulic calculations of flow velocities on the slope of the Item for the appropriate erosive forces. Some common slope protection measures include: riprap, gabions, paving (concrete or asphalt), or appropriate vegetative cover.]*

3. *If slope protection is riprap, filter layer(s) under the riprap shall be designed according to established filter criteria. However, existing riprap cover may be evaluated based on performance and observations during inspections.*

4.1 LRCP DAM

4.1.1 Background

Slope protection for the LRCP Dam consists of grass with smaller areas of riprap on the upstream slope of the dam. The downstream slope is also covered with grass. Flow from the primary spillway's discharge pipe is adequately dissipated through a gradual pipe slope and discharge elevation into the receiving stream (GZA, 2009).

4.1.2 Assessment

As reported by the GZA (2009), regular drive-by inspections are performed with a checklist inspection quarterly, and an annual inspection by AEPSC. The spillway is regularly visited to take water quality samples, while the instrumentation in the dams are read monthly. Areas of erosion are prioritized for appropriate repairs. Regular site inspections performed by a registered professional engineer have been conducted and documented for the Landfill Runoff Collection Pond from 1976 to 2016. Site inspection reports generally indicate appropriate maintenance of slope protection features of the dam.

The upstream slope of the LRCP dam is vegetated with short grass. Small riprap has been placed above the normal pool towards the dam crest. At the water line, an area of short wetland grasses was observed (GZA, 2009). Riprap has been placed the length of the dam to protect against wave erosion. The last annual dam and dike inspection observed no erosion due to wave action and that the slope was in stable condition (AEPSC, 2015).

4.1.3 Conclusion

Based on the assessment of the slope protection for the LRCP Dam, the EPA Final CCR Rule-related criteria listed above have been met.

5.0 EMBANKMENT DIKE COMPACTION (§257.73(d)(1)(iii))

Per §257.73(d)(1)(iii), the initial structural stability assessment must document whether the unit has been designed, constructed, operated, and maintained with dikes mechanically compacted to a density sufficient to withstand the range of loading conditions in the CCR unit. The Landfill Runoff Collection Pond has the following features that fall within this requirement:

- LRCP Dam

Assessment of the dike compaction associated with these features was completed considering the following criteria related to the EPA Final CCR Rule:

1. Documentation showing the dike was mechanically compacted. Acceptable documentation may include construction drawings, field notes, construction photographs, correspondences, or any evidence showing the dike was mechanically compacted during construction.

2. If no construction documentation is available specific data from geotechnical explorations of dike may be used. Geotechnical borings with continuous SPTs may be used to assess

compaction of the dike. Appropriate methodology correlating blow counts and compaction (density) should be used.

5.1 LRCP DAM

5.1.1 Background

The dam was designed by Arthur and Leo Casagrande of Cambridge, Massachusetts from 1952 to 1954. The firm was also retained during the construction phase and reportedly made a number of site visits as the embankment and appurtenances were being built. Only limited design drawings exist for the LRCP Dam. Technical memoranda and letters between the firm and the plant during the design and construction of the plant and other structures do exist (GZA, 2009). Construction photos are available showing period-appropriate construction equipment working on the site. Subsurface explorations and engineering analyses of the dike were also available that provided SPT data and shear strength testing results used in the assessment.

5.1.2 Assessment

Historical construction photographs, technical memoranda, and letters provide documentation of compaction requirements related to the construction of the LRCP Dam. Construction criteria related to dike embankment materials and dike compaction as noted on this documentation include:

- A discussion of proposed dike materials and the need for proper moisture control and compaction in thin layers with heavy, rubber-tired equipment slightly on the dry side of optimum (A. Casagrande, 1952).
- A discussion of testing the foundation clay in situ with a vane borer with supervision by L. Casagrande (A. Casagrande, 1952).
- A discussion of selection of granular borrow with laboratory data and compaction requirements (A. Casagrande, 1953).
- A discussion of compaction of the foundation fill with a modern, heavy rubber-tired roller in 9-inch layers and compacted with four passes of a roller loaded to 50 or 60 tons (A. Casagrande, 1953).

Three previous geotechnical explorations were available to review as part of this assessment (AEPSC, 1985; Stantec, 2010; Stantec, 2016a). Each was a geotechnical exploration and slope stability evaluation of the LRCP Dam. The programs included drilling and laboratory testing.

AEPSC (1985) assigned undrained shear strength parameters to the existing lean clay dam of 2,500 pounds per square foot (psf) cohesion and an internal friction angle of 10 degrees based on estimates and interpretation from cone penetration testing. Stantec (2016a) assigned drained shear strength parameters to the existing lean clay dam of 198 psf and 27.5 degrees with undrained shear strength parameters of 1,400 psf and 21 degrees. Correlating these results using NAVFAC DM-7.2 indicate that appropriate compaction exists within the embankment of the LRCP Dam (NAVFAC, 1986).

Stantec (2016a) performed a moisture-density test on the embankment lean clay to compare with in-situ natural moisture contents and unit weights of the soil. Natural moisture contents within the embankment varied from 17 to 24 percent with an average of 20 percent. Dry densities ranged from 99 to 114 pounds per cubic foot (pcf) with an average of 108 pcf. The results of the tests suggested the average natural moisture content of the embankment is about 3 percent above optimum moisture and that the average percent compaction of the embankment soil is approximately 98 percent of standard Proctor maximum density.

5.1.3 Conclusion

Based on the assessment of the embankment dike compaction for the LRCP Dam, the EPA Final CCR Rule-related criteria listed above have been met.

6.0 VEGETATED SLOPES (§257.73(d)(1)(iv))

Per §257.73(d)(1)(iv), the initial structural stability assessment must document whether the unit has been designed, constructed, operated, and maintained with vegetated slopes of dikes and surrounding areas, except for slopes which have an alternate form or forms of slope protection. The Landfill Runoff Collection Pond has the following features that fall within this requirement:

- LRCP Dam

Assessment of the vegetated slopes associated with these features was completed considering the following criteria related to the EPA Final CCR Rule:

1. Regular inspection records showing vegetative cover sufficient to prevent surface erosion while allowing an unobstructed view to visually inspect the slope.

6.1 BACKGROUND

Slope protection for the LRCP Dam consists of short grass with smaller riprap areas on the upstream slope of the dam above the operating pool. Small wetland grasses are present at the base of the upstream slope. The downstream slope is covered with grass.

6.2 ASSESSMENT

Regular site inspections were conducted and documented regularly following construction of the LRCP Dam. Weekly, monthly, quarterly, and annual inspections are performed for the LRCP Dam.

In August 2015, Stantec personnel visited the site to observe existing conditions. The vegetation along the slopes of the LRCP Dam of the Landfill Runoff Collection Pond appeared mowed and maintained.

6.3 CONCLUSION

Based on the assessment of the vegetated slopes for the LRCP Dam, the EPA Final CCR Rule-related criteria listed above have been met.

7.0 SPILLWAY CONDITION AND CAPACITY(§257.73(d)(1)(v))

Per §257.73(d)(1)(v), the initial structural stability assessment must document whether the unit has been designed, constructed, operated, and maintained with a single spillway or combination of spillways that meet the condition and capacity requirements as outlined in this section of the EPA Final CCR Rule. The combined capacity of all spillways are to be designed, constructed, operated, and maintained to adequately manage flow during and following the peak discharge from the event specified in this section. The Landfill Runoff Collection Pond has the following features that fall within this requirement:

- LRCP Dam Primary Spillway System

Assessment of the spillway condition and capacity associated with these features was completed considering the following criteria related to the EPA Final CCR Rule:

1. Outlet channel must be of non-erodible material designed to carry sustained flow velocities based on the required flood events. [Estimate flow velocities and select appropriate material using hydraulic analysis for the following flood events: PMF (high hazard potential unit), 1000-year flood (Significant hazard unit), 100-year flood (low hazard potential unit).]

2. Must adequately manage flow during and following the peak discharge. [Estimate size of outlet structure based of hydraulic analysis for the following flood events: PMF (High hazard potential unit), 1000-year flood (Significant hazard potential unit), and 100-year flood (low hazard potential unit).]

3. Must be structurally stable. [Assess stability of structure using stability and stress analyses according to an appropriate methodology. Some acceptable methodologies may include: EM 1110-2-2400, EM 1110-2-2100, ACI 350, etc.]

4. Must maintain structural integrity. [Structural integrity may be warranted by periodic inspections of existing conduits. Inspections must show no significant presence of deformation, distortions, cracks, joint separation, etc.]

5. Must be free from significant amounts of obstruction and anomaly which may affect the operation of the hydraulic structure [Perform periodic pipe inspections to detect deterioration, deformation, distortion, bedding deficiencies, and sediment, and debris accumulations.]

7.1 PRIMARY SPILLWAY SYSTEM

7.1.1 Background

The Landfill Runoff Collection Pond is classified as a significant hazard structure requiring the combined capacity of all spillways be adequate to manage the flow during and following the peak discharge from a 1000-year flood.

7.1.2 Assessment

7.1.2.1 Spillway Capacity

The Inflow Design Flood Control System Plan for the Landfill Runoff Collection Pond demonstrates the Landfill Runoff Collection Pond meets the capacity requirements outlined in §257.73(d)(1)(v) of the EPA Final CCR Rule. During the October 2015 annual dam and dike inspection, the primary spillway's outlet structure was freely discharging with no observed deficiencies or blockages (AEPSC, 2015).

7.1.2.2 Structural Stability

The Landfill Runoff Collection Pond spillway is a decant-type structure built along the natural slope near the right LRCP Dam abutment. The slope intake shaft is rectangular with a 3-foot by 6-foot cross section. It slopes at 2H:1V to 4H:1V to reflect natural ground. The top of the structure is approximately elevation 503 feet (AEPSC, 2016). There are four main intake elevations: 485.87, 490,79, 496.74, and 501.61 feet (FMSM, 2006).

A 72-inch extra strength reinforced concrete pipe connects to the decant structure at elevation 432.0 feet and discharges downstream to Panther Creek, flowing 700 feet to the Ohio River. The creek outlet is a reinforced concrete head wall with training walls with an invert at the pipe outlet of 430 feet (GZA, 2009).

The 390-foot-long discharge pipe is set on a 7.6-foot concrete cradle at the prepared foundation elevation. A series of 54 vertical steel struts are spaced at 4-foot centers within the pipe to add reinforcement due to the embankment fill weight. The joints of the reinforced concrete discharge pipe are cemented with rubber gaskets. Three 8-inch concrete water stops are placed on the upstream portion of the discharge pipe at 30-foot centers under the LRCP Dam (GZA, 2009).

The Landfill Runoff Collection Pond's spillway structure is inspected monthly during water quality sampling and annually as part of the dam and dike inspection. Physical condition, flow through the pipe, and maintenance concerns are noted and addressed. A recent 2009 video camera inspection of the structure was performed by Zemba Brothers of Zanesville, Ohio. A minor seep within the pipe was noted and addressed by an inflatable ring to seal the zone. Manned inspections of the structure were performed prior to 2009.

7.1.3 Conclusion

Based on the assessment of the primary spillway system condition and capacity for the Landfill Runoff Collection Pond, the EPA Final CCR Rule-related criteria listed above have been met.

8.0 SUDDEN DRAWDOWN ASSESSMENT (§257.73(d)(1)(vii))

Per §257.73(d)(1)(vii), the initial structural stability assessment must document whether the unit has been designed, constructed, operated, and maintained with downstream slopes that can be inundated by an adjacent water body (such as a river, stream, or lake) to determine if structural stability is maintained during low pool or sudden drawdown of the adjacent water body. The Landfill Runoff Collection Pond has the following feature that falls within this requirement:

- LRCP Dam

Assessment of the sudden drawdown associated with these features was completed considering the following criteria related to the EPA Final CCR Rule:

1. Maintain slope stability during sudden drawdown of adjacent water body.

Guidance provided by the USEPA (2015) described the basis of the EPA Final CCR Rule's factor of safety criteria and methodology as EM 1110-2-1902 (USACE, 2003) or other appropriate methodologies. Table 3-1 of EM 1110-2-1902 (USACE, 2003) recommends a required minimum factor of safety of 1.1 for maximum surcharge pool under rapid drawdown conditions.

8.1 EMBANKMENTS

8.1.1 Background

The LRCP Dam has a potential sudden drawdown loading from the Ohio River. A sudden drawdown slope stability analysis of the downstream slope is required under the EPA Final CCR Rule §257.73(d)(1)(vii). The sudden drawdown slope stability analysis was performed in conjunction with the static safety factor assessment discussed in Stantec (2016a).

8.1.2 Assessment

8.1.2.1 Material Properties

Stantec performed geotechnical explorations in 2010 and 2015 to characterize the embankment of the LRCP Dam. A laboratory testing program was performed for each exploration to determine the pertinent soil parameters for stability analyses. The strength parameters derived using the laboratory data and used in this sudden drawdown slope stability evaluation are presented in Table 1. The results of the laboratory testing and derivation of the strength parameters can be found in Stantec (2010 and 2016a).

Table 1 Strength Parameters for Stability Analysis – LRCP Dam

Soil Horizon	Unit Weight (pcf)	Effective Stress Strength Parameters		Total Stress Strength Parameters	
		c' (psf)	ϕ' (degrees)	c (psf)	ϕ (degrees)
Embankment	129	198	28	1,400	21
Lean Clay with Sand	127	206	28	1,200	17
Silty Sand	94	0	30	0	30
Silty Clay with Sand	118	152	34	1,000	20
Sandy Silt	125	0	30	0	30
Clayey Gravel with Sand	130	0	35	0	35
Fly Ash	115	0	25	0	25

8.1.2.2 Critical Cross Section Selection

Slope stability analyses were available from Stantec (2010 and 2016a). Two cross sections through the LRCP Dam were analyzed under static, steady-state conditions using the maximum surcharge pool. The two sections that were analyzed are labeled Sections D-D' and E-E' and are shown below in Figure 2.

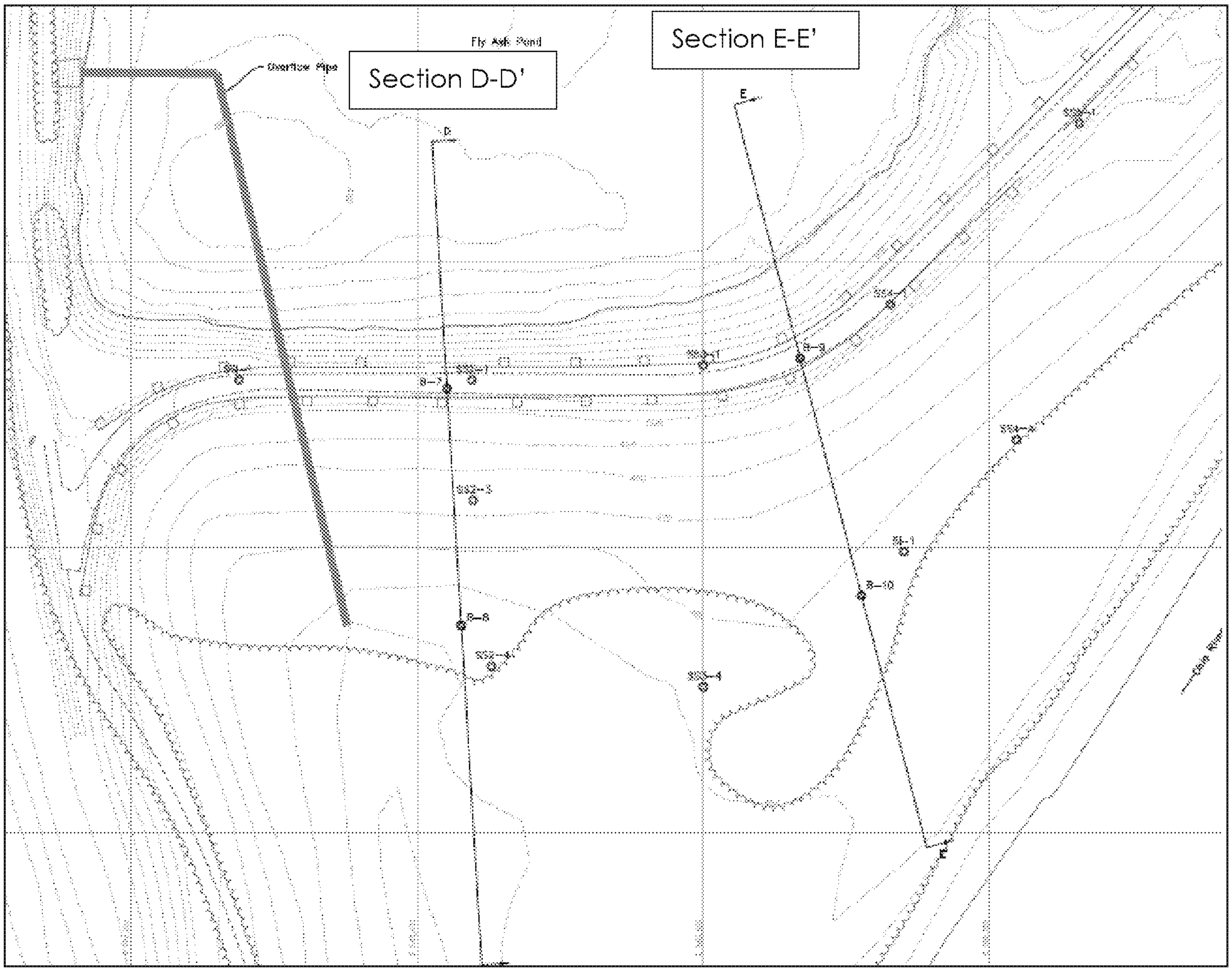

Figure 2 Clifty Creek LRCP Dam – Plan View of Cross Sections

The summary of the slope stability results from Stantec (2016a) is listed in Table 2. The pond levels were set at the 50% PMP elevation (501.4 feet for the Landfill Runoff Collection Pond). The tailwater was set near the elevation of the Ohio River.

Table 2 Slope Stability Results

Facility	Cross-Section	Maximum Surcharge Pool Factor of Safety
Landfill Runoff Collection Pond	D-D'	1.81
	E-E'	1.99

A sudden drawdown stability analysis is required for Section D-D' as the critical cross section for the LRCP Dam using the proposed water levels discussed in Section 8.1.2.3.

8.1.2.3 Water Levels

Clifty Creek Station's CCR surface impoundments are classified as significant hazard. Under the EPA Final CCR Rule, the inflow design flood for a significant hazard potential CCR surface impoundment is the 1,000-year flood (§257.82(a)(3)(ii)). A rainfall amount for the 1,000-year storm event (7.19 inches) was obtained from the "Precipitation Frequency Atlas of the United States, NOAA Atlas 14" using a precipitation event duration of 6 hours (Bonnin et al, 2016).

Stantec (2016b) presents the reservoir routing analysis for the Landfill Runoff Collection Pond assuming the probable maximum precipitation (PMP) event for existing and future landfill conditions. From NOAA (1980), a 6-hour rainfall depth (27.6 inches) for the PMP storm event as obtained. The reservoir routing model indicates that the Landfill Runoff Collection Pond existing and proposed conditions peak PMP water surface elevations are 500.4 and 501.4 feet, respectively.

The sudden drawdown analysis has been performed assuming a maximum surcharge pool within the surface impoundment equal to the probable maximum flood (PMF) and a long-term maximum storage pool equal to the operating pool elevation reported in Stantec (2016a).

Tailwater for the model is the Ohio River elevation. The 100-year flood level for the Ohio River was used for the tailwater flood pool elevation (FEMA, 2015). The normal pool for the Ohio River was determined from the elevations provided by NOAA (2016) for Madison, Indiana. Table 3 lists the headwater and tailwater elevations used for analysis.

Table 3 Clifty Creek Station Water Elevations for Stability Modeling

CCR Rule Criteria	Headwater Landfill Runoff Collection Pond Elevation (feet)	Tailwater Ohio River Elevation (feet)
Long-term maximum storage pool loading condition	485.0	420.0
Maximum surcharge pool loading condition	501.4	463.0

8.1.2.4 Analysis Methodology

Stantec performed the sudden drawdown slope stability analyses using the GeoStudio 2007, Version 7.23 software package developed by GEO-SLOPE International, Ltd. of Calgary, Alberta, Canada (GEO-SLOPE International, Ltd., 2007). This package includes the SLOPE/W module for slope stability analysis. The analyses were performed in accordance with the recommendations and criteria outlined in the USACE Design Manual EM 1110-2-1902 "Slope Stability" (USACE, 2003).

8.1.2.5 Acceptance Criteria

A minimum factor of safety is not explicitly specified within the EPA Final CCR Rule §257.73(d)(1)(vii). In the EPA CCR Final Rule discussion, USACE (2003) is considered the basis for the slope stability analyses. Table 3-1, Minimum Required Factors of Safety: New Earth and Rock-Fill Dams, requires a factor of safety of 1.1 for a rapid drawdown condition from maximum surcharge pool.

8.1.2.6 Analysis Results

The slope stability assessment presented in this report is focused on the potential for slope failures of significant mass, which could directly impact potential release of water and CCR materials from the Landfill Runoff Collection Pond. The search for a critical slip surface in the slope stability assessment is thus restricted to consider only potential surfaces where the depth (measured at the base of at least one slice) is more than ten feet vertically below the ground surface. Table 4 summarizes the sudden drawdown safety factor evaluation results at the LRCP Dam Section D-D'. The results of the analysis are included in Appendix B.

The results show that the sudden drawdown factor of safety assuming the PMP event meets the criteria; therefore, the design is also acceptable for the 1000-year event and the requirements set forth in 40 CFR 257.73(d)(1)(vii).

Table 4 Factor of Safety Assessment Results

Facility	Cross Section	EPA Final CCR Rule Criteria	Recommended Factor of Safety Criteria	Calculated Factor of Safety
Landfill Runoff Collection Pond	D-D'	Sudden Drawdown	1.1	1.8

8.1.3 Conclusion

Based on the assessment of the sudden drawdown for LRCP Dam, the EPA Final CCR Rule-related criteria listed above has been met.

9.0 REFERENCES

American Electric Power Service Corporation (AEPSC) (2016). *History of Construction. CFR 257.73(c)(1). Landfill Runoff Collection Pond. Clifty Creek Plant*. Madison, Indiana. GERS-16-141.

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Appendix A PLAN VIEW OF CLIFTY CREEK STATION

Appendix B SUDDEN DRAWDOWN ASSESSMENT

APPENDIX A
PLAN VIEW OF CLIFTY CREEK STATION

561022 564303 567584 570865

449474 446193 442912

Figure No.
A-1

Title
Plan View of Clifty Creek Station

Client/Project
Clifty Creek Station - Structural Stability
Landfill Runoff Collection Pond and
West Boiler Slag Pond

Project Location 175534018

Madison
Jefferson County, IN

Prepared by AP on 2016-10-13
Technical Review by JH on 2016-10-13
Independent Review by SH on 2016-10-13

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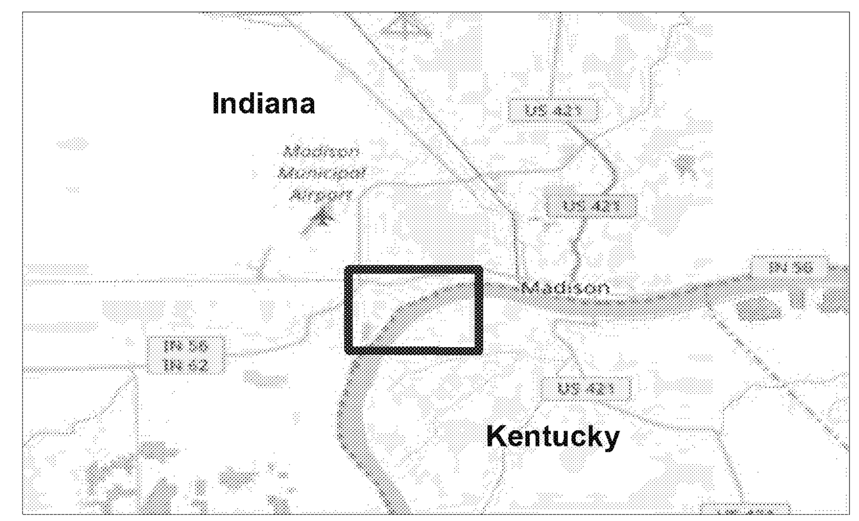
1:6,000 (At original document size of 11x17)



Notes
1. Coordinate System: NAD 1927 StatePlane Indiana East FIPS 1301
2. USDA - NAIP 2014 Ortho-Imagery
3. Fuller, Mossbarger, Scott, & May, Inc. (FMSM) (2006b). Permit Drawings. Indiana-Kentucky Electric Corporation. Clifty Creek Coal Ash Landfill Modification. Jefferson County, Madison Township, Indiana. November. Dwg. No. 16-30500-09-A. Coal Ash Landfill. Top of Cover

Stantec OVEC IKEC

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APPENDIX B
SUDDEN DRAWDOWN ASSESSMENT

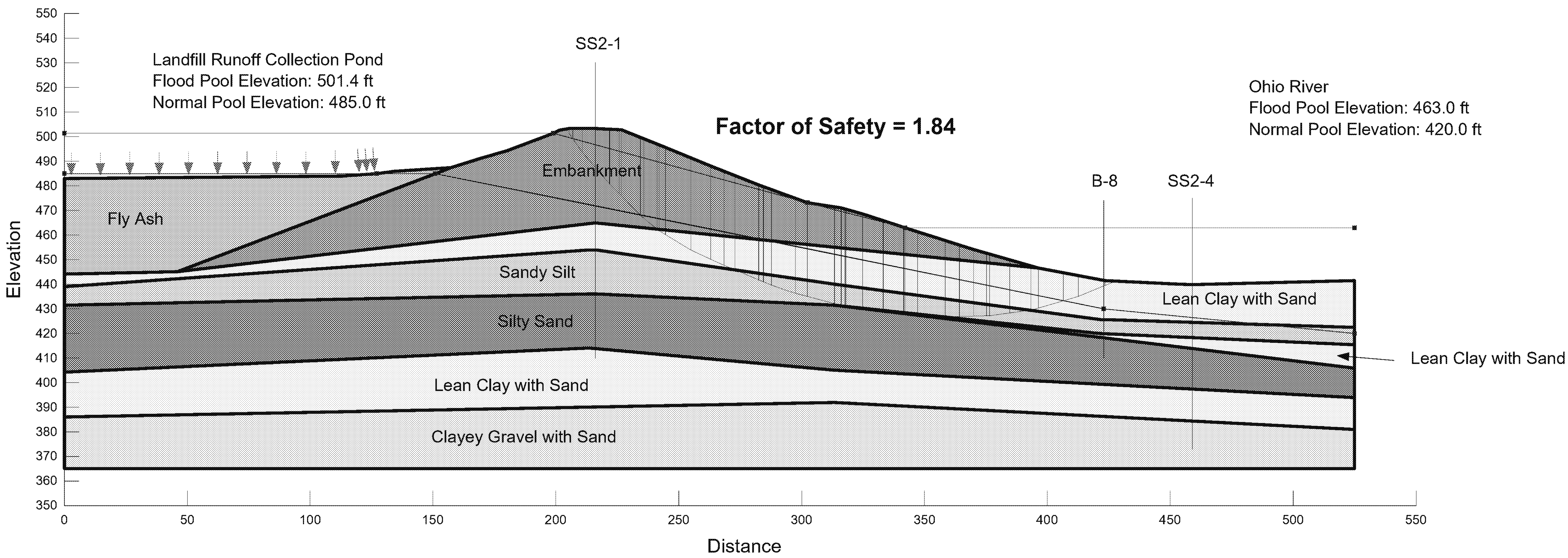
Indiana-Kentucky Electric Corporation
Clifty Creek Station
Landfill Runoff Collection Pond Dam
Madison, Indiana
Section D-D'

Existing Geometry
Sudden Drawdown
Undrained, Sudden Drawdown Strengths

Note: The results of the analysis shown here are based on available subsurface information, laboratory test results and approximate soil properties. The drawing depicts approximate subsurface conditions based on historical drawings or specific borings at the time of drilling. No warranties can be made regarding the continuity of subsurface conditions.

Sudden Drawdown

Material Type	Unit Weight	Effective - c'	Effective - phi	Total - c	Total - phi
Embankment (SDD)	129 pcf	198 psf	27.5 °	1400 psf	21 °
Lean Clay with Sand (SDD)	127 pcf	206 psf	28 °	1200 psf	17 °
Sandy Silt (SDD)	125 pcf	0 psf	30 °	0 psf	30 °
Silty Sand (SDD)	94 pcf	0 psf	30 °	0 psf	30 °
Clayey Gravel with Sand (SDD)	130 pcf	0 psf	35 °	0 psf	35 °
Fly Ash (SDD)	115 pcf	0 psf	25 °	0 psf	25 °



APPENDIX E8 – SAFETY FACTOR ASSESSMENT

Report of CCR Rule Stability Analyses
AEP Clifty Creek Power Plant Boiler Slag Pond Dam and Landfill Runoff Collection Pond

Madison, Jefferson County, Indiana

Prepared for:
American Electric Power
Columbus, Ohio

Prepared by:
Stantec Consulting Services Inc.
Cincinnati, Ohio

February 16, 2016

Table of Contents

LIST OF TABLES

Executive Summary

The Clifty Creek Power Station's Boiler Slag Pond Dam, owned and operated by the Indiana and Kentucky Electric Corporation (IKEC), is located in the city of Madison, Indiana along the northern bank of the Ohio River. The Boiler Slag Pond currently serves as a settling facility for sluiced bottom ash produced at the plant. In addition to the process flows from the plant, approximately 510 acres drain to the facility. The pond is formed by natural grade to the north, east, and west; as well as a southern dike that runs along the bank of the Ohio River.

The Landfill Runoff Collection Pond serves as a collection pond for the Coal Combustion Byproducts Landfill. The pond is formed by natural grades to the north, east, and west; as well as a southern dam that runs along the bank of the Ohio River. The drainage area of the pond is approximately 443 acres. The Indiana Department of Natural Resources (IDNR) has designated this dam as No. 39-12, which was registered as a High Hazard Structure in 2010.

Stantec Consulting Services Inc. (Stantec) was contracted to perform a geotechnical exploration, stability analysis, and liquefaction assessment of the dike for these facilities in 2009 (Landfill Runoff Collection Pond) and in 2010 (Boiler Slag Pond Dam). The intent of the explorations was to develop subsurface data at cross-sections along the dike for the Boiler Slag Pond and the dam for the Landfill Collection Runoff Pond and to perform conventional seepage and stability analyses, assessing the performance of the facilities. The potential for liquefaction was to be evaluated according to simplified published methods. Reports from past geotechnical explorations were used to supplement subsurface data.

In response to the Coal Combustion Residual (CCR) rules mandated in the Federal Register on April 17, 2015, AEP contracted Stantec to perform stability analyses for the Boiler Slag Pond Dam and Landfill Runoff Collection Pond to estimate static, seismic, and liquefaction potential factors of safety. According to Section 257.73(e)(1)(i) through (iv), the factor of safety assessment CCR rules are:

(i) The calculated static factor of safety under the long-term, maximum storage pool loading condition must equal or exceed 1.50.

(ii) The calculated static factor of safety under the maximum surcharge pool loading condition must equal or exceed 1.40.

(iii) The calculated seismic factor of safety must equal or exceed 1.00

(iv) For dikes constructed of soils that have susceptibility to liquefaction, the calculated liquefaction factor of safety must equal or exceed 1.20.

The factors of safety obtained during the analyses for static and seismic load cases were greater than those required for Section 257.73 (e)(1)(i) through (iii). The average factor of safety for each soil horizon that was susceptible to liquefaction was greater than that required in Section 257.74 (e)(1)(iv).

The results of the 2010 analyses can be found in Section 6.1.1 for the Boiler Slag Pond Dam and Section 6.1.2 for the Landfill Runoff Collection Pond. The results of the 2015 CCR review can be found in Section 6.1.2 for the Boiler Slag Pond Dam and Section 6.2.2 for the Landfill Runoff Collection Pond.

1.0 INTRODUCTION

The Clifty Creek Power Station's Boiler Slag Pond Dam, owned and operated by the Indiana and Kentucky Electric Corporation (IKEC), is located in the city of Madison, Indiana along the northern bank of the Ohio River. The Boiler Slag Pond currently serves as a settling facility for sluiced bottom ash produced at the plant. In addition to the process flows from the plant, approximately 510 acres drain to the facility. The pond is formed by natural grade to the north, east, and west; as well as a southern dike that runs along the bank of the Ohio River.

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(i) The calculated static factor of safety under the long-term, maximum storage pool loading condition must equal or exceed 1.50.

(ii) The calculated static factor of safety under the maximum surcharge pool loading condition must equal or exceed 1.40.

(iii) The calculated seismic factor of safety must equal or exceed 1.00

(iv) For dikes constructed of soils that have susceptibility to liquefaction, the calculated liquefaction factor of safety must equal or exceed 1.20.

Table 1 summarizes the geometric characteristics of the embankments.

Table 1 Clifty Creek Facility Geometry

Facility Section	Height (feet)	Crest Width (feet)	Downstream Slope Grade	Upstream Slope Grade
Boiler Slag Pond Section A-A'	41	22	2.5H:1V*	1.75H:1V*
Boiler Slag Pond Section B-B'	31	30	2.5H:1V*	1.5H:1V*
Boiler Slag Pond Section C-C'	35	30	2H:1V*	2H:1V*
Landfill Runoff Collection Pond Section D-D'	61	20	2.5H:1V*	3H:1V*
Landfill Runoff Collection Pond Section E-E'	51	20	2.5H:1V*	4.5H:1V*

*Denotes horizontal to vertical ratio

2.0 GEOLOGY OF THE SITE

The site lies within the Muscatatuck Regional Slope Physiographic Region of Indiana. This gently sloping plain is made of bedrock that is mostly Devonian in age that has been dissected by streams. Along the Ohio River the uplands immediately to the north are rugged and stand in bold relief to the flood plain. The reaches of each drainageway typically contain accumulations of silt, clay, and sand that make up the flat-lying flood plains. The site topography is steep to moderately sloping toward natural drainage channels. Topographic relief between Clifty Creek Power Plant and the uplands to the north is on the order of 350 feet.

Published soils information for the site was obtained from the Soil Survey of Jefferson County, Indiana, (US Department of Agriculture [USDA], Natural Resources Conservation Service [NRCS], 1985). The soil survey indicated the side slopes of Devil's Backbone and the ridge flanks to the north of the site belong to the Eden-Caneyville complex (EgG). These soils are found on steep to very steep slopes ranging from 25 to 60 percent. The Eden-Caneyville complex consists of moderately deep and well-drained soils that formed on slopes facing the Ohio River and on back slopes facing adjacent to tributaries near the river.

Mapping of unconsolidated sediments obtained from Regional Geologic Map, Louisville Sheet, Part B (Indiana Department of Natural Resources [IDNR], 1972) indicates the lowland areas adjacent to the Ohio River are predominantly underlain by clay, silt, sand, and gravel deposited as alluvium, lacustrine and outwash deposits. The glacial deposits in the area are of the Illinoian and Wisconsinan Quaternary age and belong to the Atherton Formation. The overlying more recent alluvial deposits belong to the Martinsville Formation.

The Atherton Formation consists of coarse- to fine-grained, well-sorted sediments that were deposited by glacial outwash (sand and gravel deposited by glacial meltwater streams), lake sediments and loess. The Martinsville Formation consists of alluvial sediments of non-glacial origin that have been deposited in modern flood plains along the major drainage ways. This formation varies in thickness from a few inches up to 30 feet near rivers.

Available geologic mapping from Bedrock Geology of Indiana (Indiana Geological Survey [IGS] Miscellaneous Map 48, IGS, 1987) shows the site to be underlain by bedrock of the Maquoketa Group. The Maquoketa Group in Indiana is a westward-thinning wedge, 1,000 feet thick in southeastern Indiana and 200 feet thick in northwestern Indiana. Overall, the group consists principally of shale (about 80 percent) and limestone (about 20 percent), although limestone is dominant in some areas. The lower part of the group is almost entirely shale, and the lower part of the shale is dark brown to nearly black. These rocks were deposited during the Upper Ordovician Period.

3.0 FIELD EXPLORATIONS AND SITE RECONNAISSANCE

The borings for the 2009 and 2010 geotechnical exploration were advanced using 3¼-inch inside-diameter hollow-stem augers powered by a truck-mounted drill rig. Standard penetration tests (SPTs) were performed at 2.5-foot intervals in accordance with ASTM D 1586. Undisturbed Shelby tube samples were performed at selected intervals to obtain samples for consolidated-undrained (CU) triaxial compression (ASTM D 4767) and permeability testing (ASTM D 5084-90). Sample depths and recovery amounts are presented on the boring logs. Additionally, disturbed bag samples were collected from auger cuttings obtained from the boreholes.

A Stantec geotechnical engineer directed the drill crews, logged the subsurface materials encountered during the exploration and collected soil samples. During field logging, particular attention was given to each material's color, texture, moisture content, and consistency or relative density.

Following the field explorations, the Shelby tubes and bag samples were transported to Stantec's (or certified vendor's) laboratory for testing. Natural moisture content and unit weight testing were performed on samples extruded from the tubes. Testing consisting of sieve and hydrometer analyses (ASTM D 422) and Atterberg limits (ASTM D 4318) was performed on representative samples in order to classify the soil according the Unified Soil Classification System (USCS). Consolidated undrained triaxial compression tests (ASTM D 4767) and falling head permeability tests (ASTM D 5084) were also performed on Shelby tube samples. Standard Proctor moisture-density testing (ASTM D 698) was performed on disturbed soil bag samples collected from the auger cuttings.

3.1 BOILER SLAG POND DAM

3.1.1 2010 Geotechnical Exploration

Stantec advanced six borings at the dike of the Boiler Slag Pond Dam near the locations requested by AEP. The boring locations are shown in Appendix A. Borings B-1, B-3, and B-5 were positioned along the crest of the dike and Borings B-2, B-4, and B-6 were located along the downstream toe.

Upon completion of drilling, one-inch diameter standpipe piezometers were installed in four of the borings (Borings B-1, B-3, B-4, and B-5). In these, ten-foot long sections of polyvinyl chloride (PVC) well screen were placed in the borehole with the bottoms at approximate depths ranging from 30 to 40 feet. PVC riser tubing extended to the tops of the piezometers. Flush-mount well covers were installed along the crest of the dike (Borings B-1, B-3, and B-5) and an above-ground steel tube cover was used at the toe of the downstream slope (Boring B-4). Refer to Appendix C for piezometer installation details.

3.1.2 2015 CCR Mandate Site Reconnaissance

Representatives from Stantec visited the Boiler Slag Pond Dam for a site reconnaissance on August 25, 2015. The purpose of this visit was to confirm that physical conditions at the pond, such as geometry of the embankment, pool elevations, etc. had not changed since the completion of the analysis in 2010. The crest and exterior slopes of the pond were walked by Stantec personnel, while the interior slopes were observed from the crest. Evidence of alterations to the pond since 2010 were not observed during the reconnaissance.

3.2 LANDFILL RUNOFF COLLECTION POND DAM

3.2.1 Previous Explorations

Two historical exploration reports were used to develop subsurface profiles and engineering parameters for the onsite material. The Fly Ash Dam Raising Feasibility Report (AEP, 1985) was implemented to obtain geotechnical properties of the dams, dikes, and foundation material to perform a feasibility assessment of raising the dams by 30 feet. Approximately 22 borings with SPT sampling and 11 Cone Penetrometer Test (CPT) borings were performed for this study. This report was used to develop a subsurface profile of the dam and estimate soil properties and shear strength parameters.

The Hydrogeologic Study Report (Applied Geology and Environmental Science, Inc., 2006) summarized the piezometers and field permeability testing performed by various firms. This report was used to develop initial phreatic surfaces for the stability analyses, and the field permeability testing data were reviewed to assist in selecting hydraulic conductivity values for soil horizons in the seepage analysis.

A review of the existing data by Stantec revealed a lack of laboratory testing necessary to develop drained (long-term) shear strength parameters. Standard Proctor moisture-density testing was recommended to compare with in-situ total unit weights to estimate the apparent degree of compaction used during construction. The review of the existing data resulted in the additional exploration explained in Section 3.2.2.

3.2.2 2009 Geotechnical Exploration

Stantec advanced four additional borings along the southern dam on November 11 and 19, 2009 to collect undisturbed Shelby tube and disturbed bag samples for laboratory testing. The boring locations are shown in Appendix A. Borings B-7 and B-9 were positioned along the crest of the dam, and Borings B-8 and B-10 were located along the downstream toe of the dam embankment. The borings were numbered in sequence with the six borings drilled at the Boiler Slag Pond Dam, also advanced late in 2009.

3.2.3 2015 Geotechnical Exploration

An additional boring (B-12) was advanced on July 6-7, 2015 to confirm subsurface conditions. This boring was placed on the crest of the dam, between the two cross-sections. The location of the boring can be seen on the site plan in Appendix A. Standard Penetration Test samples were collected at five-foot intervals. These samples were taken to a Stantec laboratory for natural moisture content, hydrometer analyses, and Atterberg limits testing.

3.2.4 2015 CCR Mandate Site Reconnaissance

Representatives from Stantec visited the Landfill Runoff Collection Pond for a site reconnaissance on August 25, 2015. The purpose of this visit was to confirm that physical conditions at the pond, such as geometry of the embankment, pool elevations, etc. had not changed since the completion of the analysis in 2010. The crest and exterior slopes of the pond were walked by Stantec personnel, while the interior slopes were observed from the crest. Evidence of alterations to the pond since 2010 were not observed during the reconnaissance.

4.0 RESULTS OF EXPLORATIONS

Logs of borings are provided in Appendix B and shown graphically on stability analysis cross sections in Appendix I for the 2009 and 2010 explorations. Results of natural moisture content tests and SPTs are provided on the logs adjacent to the appropriate sample. Summaries of engineering classification tests are provided in Appendix D.

4.1 BOILER SLAG POND DAM

4.1.1 2010 Geotechnical Exploration

4.1.1.1 Boring B-1

Boring B-1 was on the crest along cross-section A-A' of the Boiler Slag Pond Dam. The surface elevation of this boring was 473.4 feet.

Lean clay with sand was observed from the surface of the boring to a depth of 67.5 feet (Elevation 405.9 feet). From the surface of the boring to a depth of 37.5 feet (Elevation 435.9 feet), this material was described as light yellowish brown with light gray, damp to moist, and medium stiff to stiff. Natural moisture contents ranged from 15 to 23 percent and SPT N-values varied from 7 to 15 blows per foot (bpf). A liquid limit of 32 percent and a plasticity index of 13 percent were determined for a sample from this horizon. This sample was classified as CL, lean clay with sand, according to the Unified Soil Classification System (USCS) and A-6 (10) according to the Association of American State and Highway Transportation Officials (AASHTO) system. The average total unit weight of undisturbed samples was 131 pounds per cubic foot (pcf).

From a depth of 37.5 to 67.5 feet (Elevation 435.9 to 405.9 feet), the lean clay with sand was described as light yellowish brown with light gray, moist to wet, and very soft to medium stiff. Natural moisture contents ranged from 20 to 37 percent and SPT N-values varied from 2 to 7 blows per foot. A liquid limit of 28 percent and a plasticity index of 12 percent were determined for this soil. A Shelby tube sample yielded a total unit weight of 129 pounds per cubic foot. A representative sample from this layer classified as CL, lean clay with sand, according to the USCS and A-6 (8) according to the AASHTO system.

Bedrock, described as weathered gray shale, was encountered at a depth of 67.5 feet (Elevation 405.9 feet) and was augered to a boring termination depth of 71.5 feet (Elevation 401.9 feet). Groundwater was observed during the drilling at a depth of 40.0 feet (Elevation 433.4 feet) during drilling.

4.1.1.2 Boring B-2

Boring B-2 was advanced at the downstream toe along the same cross-section as Boring B-1 at a surface elevation of 444.0 feet.

From the surface of the boring to a depth of 51.5 feet (Elevation 392.5 feet), lean clay with sand was observed. The top 30 feet of this deposit was described as light yellowish brown with gray, moist to wet, and soft to very stiff. Moisture contents ranged from 17 to 32 percent and SPT N-values varied from 2 to 19 bpf, with an average of 7 blows per foot. The average total unit weight of the soil was 124 pounds per cubic foot.

The lower 21.5 feet of the lean clay with sand was described as gray, moist to wet, and soft to medium stiff. Natural moisture contents ranged from 25 to 35 percent and SPT N-values varied from 2 to 6 blows per foot. A liquid limit of 33 percent and plasticity index of 18 percent was determined for this material. A representative sample of this soil classified as CL, lean clay with sand according to the USCS and A-6 (13) according to the AASHTO system. Total unit weights of 117 and 121 pcf were determined for Shelby tube samples.

From a depth of 51.5 to 55.5 feet (Elevation 392.5 to 388.5 feet), well-graded gravel with silt and sand was observed. Bedrock was encountered below this material, described as shale, gray, hard, and medium bedded. Groundwater was observed at a depth of 22.5 feet (Elevation 421.5 feet) during drilling.

4.1.1.3 Boring B-3

Boring B-3 was positioned on the crest of the dike along cross-section B-B'. The surface elevation of the boring was 471.6 feet.

Lean clay with sand, described as light yellowish brown with light gray, was observed from the boring surface to a depth of 37.5 feet (Elevation 434.1 feet). The soil was further described as damp to moist and medium-stiff to very stiff. Moisture contents ranged from 15 to 22 percent and SPT N-values varied from 8 to 17 blows per foot. The average total unit weight was 131 pounds per cubic foot.

Gray lean clay with sand was observed below the upper soil horizon to the termination depth of 71.5 feet (Elevation 400.1 feet). This soil was described as moist and soft to very stiff. Moisture contents ranged from 20 to 40 percent and SPT N-values varied from 2 to 18 bpf, with an average of 6 blows per foot. The average total unit weight was 126 pounds per cubic foot.

Groundwater was observed at a depth of 40.0 feet (Elevation 431.6 feet) during drilling. Bedrock was not encountered.

4.1.1.4 Boring B-4

Boring B-4 was located along the downstream toe of the dike, downhill from Boring B-3, at a surface elevation of 444.0 feet.

Brown to dark gray lean clay with sand was observed from the surface of the boring to a depth of 15.0 feet (Elevation 429.0 feet). The soil was described as damp to moist and medium stiff to very stiff. Natural moisture contents ranged from 14 to 22 percent and SPT N-values varied from 7 to 16 blows per foot.

Gray lean clay with sand was encountered below the upper soil horizon to a depth of 57.5 feet (Elevation 386.5 feet) and was described as moist to wet and soft to stiff. Moisture contents varied from 21 to 35 percent and SPT N-values varied from 3 to 9 blows per foot. A representative sample yielded a liquid limit of 25 percent and a plasticity index of 8 percent. This material classified as CL, lean clay with sand, according to the USCS and A-4 (4) according to the AASHTO system.

Underlying the lean clay with sand, well-graded gravel with silt and sand was observed to a termination depth of 71.5 feet (Elevation 372.5 feet). This material was described as gray, wet, and dense to very dense. Moisture contents ranged from 9 to 13 percent and SPT N-values varied from 39 to over 50 blows per foot. A representative sample of this material tested as non-plastic and classified as GW-GM, well-graded gravel with silt and sand, according to the USCS and A-1-a (1) according to the AASHTO system.

Bedrock was not encountered in the boring. Groundwater was observed at a depth of 22.5 feet (Elevation 421.5 feet) during drilling.

4.1.1.5 Boring B-5

Boring B-5 was advanced from the crest of the dike on cross-section C-C'. The surface elevation was 468.7 feet.

Lean clay with sand was observed from the surface of Boring B-5 to a depth of 40.0 feet (Elevation 428.7 feet). The soil was described as light yellowish brown with light gray, damp to moist, and medium stiff to very stiff. Natural moisture contents ranged from 15 to 25 percent and SPT N-values varied from 6 to 19 blows per foot. The average total unit weight of the soil was 128 pounds per cubic foot.

Additional lean clay with sand was encountered below the uppermost layer to a depth of 47.5 feet (Elevation 421.2 feet). This material was described as gray, moist to wet, and soft. Natural moisture contents ranged from 23 to 25 percent and SPT N-values varied between 3 and 4 blows per foot. The total unit weight was 119 pounds per cubic foot.

Below the lean clay with sand, sandy silt was observed to the termination depth of 71.5 feet (397.2 feet). The sandy silt was described as light yellowish brown to gray, wet, and soft to stiff. Moisture contents ranged from 22 to 30 and SPT N-values varied from 2 to 13 bpf, with an average of 7 blows per foot. A representative sample from this horizon tested as non-plastic and classified as ML, sandy silt, according to the USCS and A-4 (0) according to the AASHTO system.

Bedrock was not encountered in the boring. Groundwater was encountered at a depth of 45.0 feet (Elevation 423.7 feet) during drilling.

4.1.1.6 Boring B-6

Boring B-6 was advanced from a surface elevation of 445.5 feet near the southeast toe of slope below Boring B-5.

Lean clay with sand was encountered from the surface to a depth of 27.5 feet (Elevation 418.0 feet). This material was described as brown to gray, damp to moist, and very soft to very stiff. Natural moisture contents ranged from 16 to 32 percent and SPT N-values varied from 0 to 18 bpf, with an average of 6 blows per foot. The average total unit weight was 117 pounds per cubic foot.

Sandy silt was observed below the lean clay with sand to the boring termination depth of 71.5 feet (Elevation 374.0 feet). This soil was described as gray, moist to wet, and very soft to stiff. Moisture contents ranged from 27 to 40 percent and SPT N-values varied from 1 to 11 bpf, with an average of 5 blows per foot. The total unit weight was 117 pounds per cubic foot.

Bedrock was not encountered in the boring. Groundwater was observed at a depth of 30.0 feet (Elevation 415.5 feet) during drilling.

4.1.1.7 Piezometers

Piezometers were installed on the crest in Borings B-1, B-3, and B-5, and at the downstream toe in Boring B-4. Details of piezometers installations are shown in Appendix C. Ten-foot long piezometers screens were installed with the tips at approximate depths of 40 feet along the crest and 30 feet at the downstream toe of slope. Table 2 summarizes the installations and first two readings performed on the piezometers.

Table 2 Summary of Piezometer Elevations for the Boiler Slag Pond Dam

Boring No.	Top of Piezometer (feet)	Tip of Piezometer (feet)	Piezometric Reading on 11/13/09 (feet)	Piezometric Reading on 02/01/10 (feet)
B-1	473.4	433.4	434.2	434.1
B-3	471.8	431.6	440.6	434.6
B-4	446.7	414.0	430.7	428.5
B-5	469.0	428.7	434.9	430.4

4.2 LANDFILL RUNOFF COLLECTION POND

4.2.1 2009 Geotechnical Exploration

4.2.1.1 Boring B-7

Boring B-7 was advanced from the crest of the dam along cross-section D-D'. The surface elevation of the boring was 503.4 feet. Approximately 0.5 feet of asphalt pavement and gravel base was observed at the surface of the boring.

Below the pavement and gravel base, lean clay was observed to a boring termination depth of 29.0 feet (Elevation 474.4 feet). The lean clay was described as yellow and light gray, moist, and stiff. Three undisturbed Shelby tube samples were obtained from a depth of 23.0 to 29.0 feet (Elevation 480.4 to 474.4 feet). Natural moisture contents of those samples ranged from 18 to 24 percent, and total unit weights varied from 128 to 133 pounds per cubic foot. A representative sample yielded a liquid limit of 28 percent and a plasticity index of 8. This sample classified as CL, lean clay, according to the USCS and A-4 (7) according to the AASHTO system.

Neither bedrock nor groundwater was encountered during drilling.

4.2.1.2 Boring B-8

Boring B-8 was located at the toe of slope downstream of Boring B-7. The surface elevation of the boring was 441.5 feet. From the surface of the boring to a depth of 16.0 feet (Elevation 425.5 feet), the soil was visually described as yellow and light gray, damp to moist, silty clay.

Below the silty clay, lean clay was encountered to a depth of 29.0 feet (Elevation 412.5 feet). The lean clay was described as yellowish brown to light gray and moist. Two undisturbed Shelby tube samples were taken from this horizon at depths of between 25.0 and 29.0 feet (Elevation 416.5 to 412.5 feet). Natural moisture contents ranged from 24 to 27 percent, and total unit weights ranged from 124 to 130 pounds per cubic foot. A representative sample of this material yielded a liquid limit of 38 percent and a plasticity index of 17 percent. The sample classified as CL, lean clay according to the USCS and A-6 (15) according to the AASHTO system.

Soil described as lean clay with sand was observed beneath the lean clay to the boring termination depth of 31.0 feet (Elevation 410.5 feet). The lean clay with sand was further described as yellowish brown and light gray and moist. Shelby tube samples yielded moisture contents of 22 and 24 percent and total unit weights of 126 and 129 pounds per cubic foot. This soil had a liquid limit of 45 percent and a plasticity index of 25 percent. The soil classified as CL, lean clay with sand according to the USCS and A-7-6 (20) according to the AASHTO system.

Neither bedrock nor groundwater was encountered during drilling.

4.2.1.3 Boring B-9

Boring B-9 was advanced along the crest of cross-section E-E' at a surface elevation of 504.3 feet. Asphalt pavement and gravel base was observed at the surface of the boring to a depth of 0.5 feet.

Lean clay was encountered below the pavement to the boring termination depth of 22.0 feet (Elevation 482.3 feet). The lean clay was described as yellow to light gray and damp to moist. Three undisturbed Shelby tube samples were obtained from a depth of 16.0 to 22.0 feet (Elevation 488.3 to 482.3 feet). Natural moisture contents ranged from 17 to 23 percent, and total unit weights varied from 119 to 135 pounds per cubic foot. A sample of this material yielded a liquid limit of 39 percent and a plasticity index of 19 percent. This sample classified as CL, lean clay, according to the USCS and A-6 (17) according to the AASHTO system.

Neither bedrock nor groundwater was encountered during drilling.

4.2.1.4 Boring B-10

Boring B-10 was positioned near the toe below Boring B-9. The surface elevation was 457.3 feet.

Silty clay with sand was observed from the surface of the boring to a depth of 13.2 feet (Elevation 444.1 feet) and from a depth of 16.0 feet to the termination depth of 18.0 feet (Elevation 441.3 to 439.3 feet). This soil was described as yellow to light gray and damp to moist. Two undisturbed Shelby tube samples were taken and natural moisture contents ranged from 21 to 28 percent. Total unit weights of the samples ranged from 116 to 124 pounds per cubic foot. A representative sample of this material yielded a liquid limit of 28 percent and a plasticity index of 7 percent. The sample classified as CL-ML, silty clay with sand according to the USCS and A-4 (5) according to the AASHTO system.

From a depth of 13.2 to 16.0 feet (Elevation 444.1 to 441.3 feet) a layer of silty sand was encountered and describe as gray-brown and damp to moist. One Shelby tube sample was taken from this layer. A representative sample of this soil classified as non-plastic SM, silty sand, according to the USCS and A-2-4 (0) according to the AASHTO system.

4.2.2 2015 Geotechnical Exploration

Boring B-12 was advanced on the crest of the dam between the analysis cross-sections. The ground surface elevation of the boring was estimated to be 503.9 feet. A layer of asphalt with gravel base was encountered at the surface of the boring to a depth of 0.4 feet (Elevation 503.5 feet).

Beneath the asphalt and gravel base, lean clay with sand was encountered to a depth of 40.0 feet (Elevation 463.9 feet). This material was described as gray, damp, and medium stiff to stiff.

The natural moisture contents ranged from 18 to 28 percent and the SPT N-values varied from 7 to 15 blows per foot. The liquid limit of this material ranged from 31 to 43 percent and the plasticity index varied from 13 to 22 percent. The material classified as CL, lean clay with sand, according to the USCS and A-6 (7) or A-7-6 (15) according to the AASHTO system.

Silty clay with sand was observed beneath the lean clay with sand to a depth of 50.0 feet (Elevation 453.9 feet). This material was described as brown, moist, and medium stiff to very stiff. The natural moisture contents ranged from 16 to 19 percent and the SPT N-values varied from 8 to 16 blows per foot. A representative sample of this material yielded a liquid limit of 26 percent and a plasticity index of 7 percent. The material classified as CL-ML, silty clay with sand, according to the USCS and A-4 (4) according to the AASHTO system.

Cohesionless material was encountered beneath the silty clay with sand to the depth of 90.0 feet (Elevation 413.9 feet). This material was silt, silt with sand, silty sand, or sand; and was described as brown or gray, damp to wet, and loose to medium dense. The natural moisture contents ranged from 15 to 28 percent and the SPT N-values varied from 6 to 28 blows per foot. Samples from these materials tested as non-plastic. The material classified as ML (sandy silt, silt, or silt with sand) or SM (silty sand) according to the USCS and A-4 (0) according to the AASHTO system.

Beneath the cohesionless material, lean clay was encountered to the boring termination depth of 101.5 feet (402.4 feet). This material was described as gray, moist, and medium stiff to very stiff. The natural moisture content ranged from 23 to 27 percent and the SPT N-values varied from 8 to 19 blows per foot. A representative sample from this material yielded a liquid limit of 42 percent and a plasticity index of 23 percent. The sample classified as CL, lean clay, according to the USCS and A-7-6 (20) according to the AASHTO system.

5.0 LABORATORY TESTING

Laboratory tests in addition to the natural moisture content, classification tests, and unit weight tests mentioned in Section 4 were conducted on samples taken from the Boiler Slag Pond Dam (2010 Geotechnical Exploration) and Landfill Runoff Collection Pond (2009 Geotechnical Exploration). The results from the additional testing are summarized in the following sections.

5.1 BOILER SLAG POND DAM

5.1.1 Consolidated-Undrained Triaxial Compression Testing

Three consolidated-undrained (CU) triaxial compression tests were performed on undisturbed samples collected from the borings. These tests were performed in accordance with ASTM D

4767, and detailed results of the tests are provided in Appendix E. The samples were described as lean clay with sand. Table 3 shows a summary of the CU triaxial tests performed.

Table 3 Summary of CU Triaxial Compression Testing for the Boiler Slag Pond Dam

Boring Nos.	Depth (feet)	Soil Description	Material	Effective Cohesion, c' (psf)	Effective Angle of Internal Friction, ϕ' (deg.)
B-3, B-5	8.1 – 11.2	Lean Clay with Sand	Embankment	330	33.2
B-2, B-4	18.2 – 24.3	Lean Clay with Sand	Foundation	320	27.2
B-1, B-3	43.1 – 48.7	Lean Clay with Sand	Foundation	170	30.2

5.1.2 Permeability Testing

Four permeability tests (ASTM D 5084, Falling-Head, Method C, Rising Tailwater) were performed on undisturbed samples. Detailed data sheets showing the results of the tests are provided in Appendix F. Vertical hydraulic conductivities ranged from 8.7×10^{-9} to 1.6×10^{-6} centimeters per second. The samples were described as lean clay with sand. Table 4 summarizes the results of the permeability tests.

Table 4 Summary of Permeability Testing for the Boiler Slag Pond Dam

Boring No.	Depth, feet	Soil Description	Material	Vertical Hydraulic Conductivity, cm/second
B-1	16.1 – 16.6	Lean Clay with Sand	Embankment	1.44×10^{-7}
B-2	42.6 – 43.1	Lean Clay with Sand	Foundation	8.70×10^{-9}
B-4	7.6 – 8.1	Lean Clay with Sand	Embankment	1.58×10^{-6}
B-6	17.6 – 18.1	Lean Clay with Sand	Foundation	2.01×10^{-7}

5.1.3 Moisture-Density Testing

Three standard Proctor moisture-density tests (ASTM D 698) were performed on bag samples taken from auger cuttings. The data sheets for these tests are provided in Appendix G.

Maximum dry densities ranged from 113.0 to 117.4 pcf and optimum moisture contents varied from 13.4 to 15.8 percent. The samples were described as lean clay with sand. Table 5 summarizes the results of the tests.

Table 5 Summary of Moisture-Density Testing for the Boiler Slag Pond Dam

Boring No.	Depth, feet	Material	Soil Description	Maximum Dry Density, pcf	Optimum Moisture Content, %
B-1	5.0 +/- 2.0	Embankment	Lean Clay with Sand	117.4	13.4
B-5	7.5 +/- 2.0	Embankment	Lean Clay with Sand	113.0	15.8

These moisture-density tests were performed to compare with natural moisture contents and unit weights of the soils. Within the embankment soils, natural moisture contents ranged from 15 to 25 percent with an average of 19 percent. Dry densities of the embankment soil ranged from 106 to 115 pcf, with an average of 110 pounds per cubic foot. The results of these tests indicate that the average natural moisture content of the embankment soil is 3 to 5 percent above optimum moisture and that the average percent compaction of the embankment soil is on the order of 94 to 97 percent of the standard Proctor maximum density.

5.2 LANDFILL RUNOFF COLLECTION POND

5.2.1 Consolidated-Undrained Triaxial Testing

Four CU triaxial compression tests were performed on undisturbed samples collected from the borings. These tests were performed in accordance with ASTM D 4767, and detailed results of the tests are provided in Appendix E. The samples were described as lean clay, lean clay with sand, or sandy clay. Table 6 shows a summary of the CU triaxial tests performed.

Table 6 Summary of CU Triaxial Compression Testing for the Landfill Runoff Collection Pond

Boring No.	Depth (feet)	Soil Description	Material	Effective Cohesion, c' (psf)	Effective Angle of Internal Friction, ϕ' (deg.)
B-7	25.8 – 29.0	Lean Clay	Embankment	430	29.3
B-8	25.8 – 30.9	Lean Clay with Sand	Foundation	410	28.0
B-9	17.4 – 21.4	Lean Clay	Embankment	360	25.7
B-10	13.4 – 18.0	Sandy Clay	Foundation	300	35.1

5.2.2 Permeability Testing

Four permeability tests (ASTM D 5084, Falling-Head, Method C, Rising Tailwater) were performed on undisturbed samples. Detailed data sheets showing the results of the tests are provided in Appendix F. Vertical hydraulic conductivities ranged from 3.4×10^{-8} to 1.4×10^{-7} centimeters per second. The samples were described as lean clay, lean clay with sand, or silt. Table 7 summarizes the results of the permeability tests.

Table 7 Summary of Permeability Testing for the Landfill Runoff Collection Pond

Boring No.	Depth, feet	Material	Soil Description	Vertical Hydraulic Conductivity, cm/second
B-7	27.4 – 27.7	Embankment	Lean Clay	8.4×10^{-8}
B-8	29.7 – 30.9	Foundation	Silt	3.4×10^{-8}
B-9	18.3 – 18.9	Embankment	Lean Clay	6.2×10^{-8}
B-10	16.4 – 16.7	Foundation	Lean Clay with Sand	1.4×10^{-7}

5.2.3 Moisture-Density Testing

One standard Proctor moisture-density test (ASTM D 698) was performed on a bag sample of embankment soil taken from auger cuttings. The data sheet for this test is provided in Appendix

G. The maximum dry density was 110.6 pcf and the optimum moisture content was 16.9 percent. The sample was described as lean clay. Table 8 summarizes the results of the tests.

Table 8 Summary of Moisture-Density Testing for the Landfill Runoff Collection Pond

Boring No.	Depth, feet	Material	Soil Description	Maximum Dry Density, pcf	Optimum Moisture Content, %
B-7	7.0 +/- 2.0	Embankment	Lean Clay	110.6	16.9

The moisture-density test was performed to compare with in-situ natural moisture contents and unit weights of the soils. Within the embankment soils, natural moisture contents varied from 17 to 24 percent with an average of 20 percent. Dry densities of the embankment soil ranged from 99 to 114 pounds per cubic foot, with an average of 108 pounds per cubic foot. The results of these tests indicate that the average natural moisture content of the embankment soil is about 3 percent above optimum moisture and that the average percent compaction of the embankment soil is approximately 98 percent of the standard Proctor maximum density.

6.0 ENGINEERING ANALYSIS

6.1 BOILER SLAG POND DAM

Based on the review of available information, results of the geotechnical exploration and results of laboratory testing, Stantec performed engineering analyses of the Boiler Slag Pond Dam in 2010. This included liquefaction, seepage, and slope stability analysis of three cross sections. The procedures used and the results of the analyses are presented in the following paragraphs. The results of the liquefaction analysis are shown in Appendix H, and the cross section drawings showing the results of the seepage and stability analyses are provided in Appendix I. Appendix J provides an explanation of derivations of shear strength, seepage, and liquefaction analysis parameters.

6.1.1 Engineering Analyses Performed in 2015 as Part of CCR Mandate

6.1.1.1 Liquefaction Analysis

The liquefaction analysis conducted in 2010 was revisited as part of the CCR Mandate. The details for this analysis are contained in Appendix H. Similar to the analysis performed in 2010, a screening process was used to determine if the cohesive material encountered in the borings has the potential for liquefaction. The screening process was conducted for four samples which had liquid limits below 37 percent. According to the Seed et al and Bray and Sancio plots supplied in Appendix H, one sample could be labeled as susceptible to liquefaction and another could be labeled as moderately susceptible to liquefaction.

The remaining cohesionless material encountered in the critical cross-sections was tested for liquefaction as a coarse–grained analysis similar to the one conducted in 2010. According to the CCR Mandate, for dikes constructed of soils that have a susceptibility to liquefaction, the calculated factor of safety must equal or exceed 1.20. Test data from Borings B-1 and B-2, representative of cross-section A-A', Boring Nos. B-3 and B-4, representative of cross-section B-B', and B-5 and B-6, representative of cross-section C-C' was used. Soil characteristics (grain size, plasticity, etc.) from SPT and Shelby tube samples were summarized to assess liquefaction potential. The copies of the spreadsheets used for the calculations appear in Appendix H and provide the soil, test data, and calculations used in the assessment.

It was assumed during the screening process for potential liquefaction that the steady-state water elevation consistent with that developed during the stability analysis would be used as the groundwater elevation. Unsaturated soils above this elevation were considered not liquefiable. Also the dike embankment materials, consisting of engineered fill, were not considered liquefiable.

Factors of safety against liquefaction were estimated for soil layers predicted to be potentially liquefiable during the screening process. As a result of recent industry publications that attempted to update certain correlations that had larger uncertainty that are used in the calculations for the factor of safety, slight differences in the factors of safety were obtained than those reported in 2010. Inputs such as depth, material properties, seismic accelerations, etc. have not been altered. Ranges and averages of these factors of safety for the potentially liquefiable soil layers are summarized in Table 9.

Table 9 Liquefaction Factor of Safety for the Boiler Slag Pond Dam, CCR Mandate

Boring No.	Depth (feet)	Elevation (feet)	Unified Soil Classification	Liquefaction FS, Range	Liquefaction FS, Average
B-2	51.5 – 56.0	392.5 – 388.0	GW-GM	10.00	10.00
B-4	57.5 – 71.5	386.5 – 372.5	GW-GM	10.00	10.00
B-5	47.5 – 71.5	421.2 – 397.2	ML	1.60 – 3.52	2.41
B-6	27.5 – 71.5	418.0 – 374.0	ML	1.08 – 2.64	1.73

The range of factors of safety for each soil horizon represents factors of safety calculated from each individual corrected N-value at that specific depth and overburden pressure. Due to the variable and somewhat unreliable nature associated with the SPT, it is recommended that the liquefaction factors of safety be evaluated according to the average values shown in Table 9. The average liquefaction factors of safety against liquefaction ranged from 1.73 to 10.00 and are considered acceptable.

6.1.1.2 Seepage Analysis

The seepage analysis conducted in 2010 was reviewed as part of the CCR Mandate. The seepage models used in the SEEP/W product were calibrated to recent piezometric data and visual field operations. Changes to the material properties developed in Appendix J of this report were not deemed necessary.

The 2010 analysis used a normal pool elevation of 442 feet to establish the piezometric line. During the 2015 site reconnaissance with AEP personnel, it was learned that the normal pool elevation is currently 448 feet and is not expected to change. As a result, a piezometric line has been adjusted for the current normal pool elevation of 448 feet, and has been used during the CCR Mandate review. The seepage analysis conducted at the critical cross-sections of A-A', B-B', and C-C' were reviewed.

The results of the seepage analysis were used to revise the stability cross-sections.

6.1.1.3 Stability Analysis

The stability analysis conducted in 2010 was reviewed as part of the CCR Mandate, using the results of the seepage analysis review in Section 6.1.1.2. Similar to 2010, SLOPE/W was the software used during the analysis. The drained shear strength parameters developed in 2010, located in Appendix J, were maintained for the updated analysis. Undrained shear strength parameters were not derived in 2010. These parameters were determined by CU test data for the Embankment Fill and Lean Clay with Sand. Undrained shear strength parameters for cohesionless materials were taken to be identical to the drained shear strength parameters.

Table 10 summarizes the drained and undrained shear strength parameters used in the analysis.

Table 10 Shear Strength Parameters for CCR Mandate Review

		Drained Shear Strengths		Undrained Shear Strengths	
Material	Unit Weight (pcf)	ϕ' (deg.)	Effective Cohesion (psf)	ϕ (deg.)	Cohesion (psf)
Embankment	130	33.2	165	13	600
Lean Clay with Sand	119	27.2	160	5	1,200
Gravel with Silt and Sand	130	35	0	35	0
Bottom Ash	115	28	0	28	0
Silty Sand	130	30	0	30	0

The upstream and downstream slopes of each cross-section were analyzed, incorporating the auto locate and entry/exit search routines to locate the critical slip surface. Once the potential failure surface with the lowest factor of safety was identified, the optimization routine was run.

When the surface slope is composed of a material with low effective cohesion, an infinite slope failure (shallow sliding parallel to the surface) will be critical. A minimum failure depth of ten feet was specified for each section, to eliminate the evaluation of surficial sloughing and erosional types of instability.

For this review, SLOPE/W was used to investigate one normal pool elevation, considered the maximum steady-state pool, and one PMF pool elevation:

- Current normal pool level of 448 feet.
- 50 Percent PMF pool level of 468.4 feet, applied as a steady-state load condition within SLOPE/W.

Using the drained and undrained strength parameters listed in Table 10, the existing dam was analyzed at the three critical cross sections selected for the CCR review. The undrained materials strengths were used in the seismic analyses.

A summary of the factors of safety are presented in Table 13 at the end of this section and printouts of the GeoStudio runs are presented in Appendix I.

6.2 LANDFILL RUNOFF COLLECTION POND

Based on the review of available information, results of geotechnical exploration and results of laboratory testing, Stantec performed engineering analyses of the Landfill Runoff Collection Pond in 2009. This included liquefaction, seepage, and slope stability analysis of two cross sections. The procedures used and the results of the analyses are presented in the following paragraphs. The results of the liquefaction analysis are shown in Appendix H, and the cross section drawings showing the results of the seepage and stability analyses are provided in Appendix I. Appendix J provides an explanation of derivations of shear strength, seepage, and liquefaction analysis parameters.

6.2.1 Engineering Analyses Performed in 2015 as Part of CCR Mandate

6.2.1.1 Liquefaction Analysis

The liquefaction analysis conducted in 2010 as part of the 2009 geotechnical exploration was revisited as part of the CCR Mandate. The details for this analysis are contained in Appendix H. Similar to the analysis performed in 2010, a screening process was used to determine if the cohesive material encountered in the borings has the potential for liquefaction. The screening process was conducted for nine samples, four of which had liquid limits below 37 percent. According to the Seed et al and Bray and Sancio plots supplied in Appendix H, none of the samples are considered susceptible to liquefaction.

The remaining cohesionless material encountered in the critical cross-sections was tested for liquefaction as a coarse–grained analysis similar to the one conducted in 2010. According to the CCR Mandate, for dikes constructed of soils that have a susceptibility to liquefaction, the calculated factor of safety must equal or exceed 1.20. Test data from historic Borings SS2-1 and SS2-4, representative of cross-section D-D' and historic Borings SI-1, SS3-1, and SS3-4, representative of cross-section E-E', were used. Soil characteristics (grain size, plasticity, etc.) from SPT and Shelby tube samples were summarized to assess liquefaction potential. The copies of the spreadsheets used for the calculations appear in Appendix H and provide the soil, test data, and calculations used in the assessment.

It was assumed during the screening process for potential liquefaction that the steady-state water elevation consistent with that developed during the stability analysis would be used as the groundwater elevation. Unsaturated soils above this elevation were considered not liquefiable. Also the dike embankment materials, consisting of engineered fill, were not considered liquefiable.

Factors of safety against liquefaction were estimated for soil layers predicted to be potentially liquefiable during the screening process. As a result of recent industry publications that attempted to update certain correlations that had larger uncertainty that are used in the calculations for the factor of safety, slight differences in the factors of safety were obtained than those reported in 2010. Inputs such as depth, material properties, seismic accelerations, etc. have not been altered. Ranges and averages of these factors of safety for the potentially liquefiable soil layers are summarized in Table 11.

Table 11 Liquefaction Factor of Safety for the Boiler Slag Pond Dam, CCR Mandate

Boring No.	Depth (feet)	Elevation (feet)	Unified Soil Classification	Liquefaction FS, Range	Liquefaction FS, Average
SI-1	14.0 – 26.0	442.6 – 430.6	ML	2.06 – 2.40	2.23
SI-1	26.0 – 36.0	430.6 – 420.6	SC	10.00	10.00
SI-1	36.0 – 41.0	420.6 – 415.6	SM	5.02	5.02
SI-1	41.0 – 79.5	415.6 – 377.1	ML	2.08 – 10.00*	4.87
SS2-1	61.0 – 66.0	443.5 – 438.5	ML	6.22	6.22
SS2-1	71.0 – 86.0	443.5 – 418.5	SM	2.41 – 10.00	6.31
SS2-4	16.0 – 21.0	423.8 – 418.8	SM	3.29	3.29
SS2-4	61.0 – 64.0	388.8 – 385.8	GC	3.50	3.50
SS3-1	36.0 – 46.0	468.5 – 458.5	ML	3.36 – 4.92	4.14
SS3-1	46.0 – 51.0	458.5 – 453.5	SP	5.34	5.34
SS3-1	51.0 – 56.0	453.5 – 448.5	SC	10.00	10.00
SS3-1	56.0 – 66.0	448.5 – 438.5	SP	3.28 – 3.84	3.56
SS3-1	66.0 – 71.0	438.5 – 433.5	SM	5.03	5.03
SS3-1	71.0 – 86.0	433.5 – 418.5	SP	2.93 – 10.00	6.25
SS3-1	86.0 – 96.0	418.5 – 408.5	SM	5.53 – 6.09	5.81
SS4-1	41.0 – 46.0	464.6 – 459.6	ML	3.28	3.28
SS4-1	46.0 – 66.0	459.6 – 439.6	SM	2.32 – 4.51	3.60
SS4-1	71.0 – 76.0	434.6 – 429.6	SC	1.83	1.83
SS4-1	76.0 – 94.0	429.6 – 411.6	ML	4.01 – 6.30	5.62

*Typical range is 2.08 – 2.93, typical average is 3.16

6.2.1.2 Seepage Analysis

The seepage analysis conducted in 2010 as a part of the 2009 geotechnical exploration was reviewed as part of the CCR Mandate. The seepage models used in the SEEP/W product were calibrated to recent piezometric data and visual field operations. Changes to the material properties developed in Appendix J of this report and the piezometric lines developed were not deemed necessary. The seepage analysis conducted at the critical cross-sections of D-D' and E-E' were reviewed.

The results of the seepage analysis were used to revise the stability cross-sections.

6.2.1.3 Stability Analysis

The stability analysis conducted in 2010 was reviewed as part of the CCR Mandate, using the results of the seepage analysis review in Section 6.2.1.2. Similar to 2010, SLOPE/W was the software used during the analysis. The drained shear strength parameters developed in 2010, located in Appendix J, were maintained for the updated analysis. Undrained shear strength parameters were not derived in 2010. These parameters were determined by CU test data for the Embankment and Lean Clay with Sand. The undrained shear strength parameters for the silty clay with sand layer were taken from established typical value tables. Undrained shear strength parameters for cohesionless materials were taken to be identical to the drained shear strength parameters.

Table 12 summarizes the drained and undrained shear strength parameters used in the analysis.

Table 12 Shear Strength Parameters for CCR Mandate Review

		Drained Shear Strengths		Undrained Shear Strengths	
Material	Unit Weight (pcf)	ϕ' (deg.)	Effective Cohesion (psf)	ϕ (deg.)	Cohesion (psf)
Embankment	129	27.5	198	21	1,400
Lean Clay with Sand	127	28	206	17	1,200
Sandy Silt	125	30	0	30	0
Silty Sand	94	30	0	30	0
Clayey Gravel with Sand	130	35	0	35	0
Fly Ash	115	25	0	25	0
Silty Clay with Sand	118	34	152	20	1,000

The upstream and downstream slopes of each cross-section were analyzed, incorporating the auto locate and entry/exit search routines to locate the critical slip surface. Once the potential failure surface with the lowest factor of safety was identified, the optimization routine was run.

When the surface slope is composed of a material with low effective cohesion, an infinite slope failure (shallow sliding parallel to the surface) will be critical. Failure was defined as any slip surface that begins in the crest with a reasonable depth of failure. A minimum failure depth was specified for each section, to eliminate the evaluation of surficial sloughing and erosional types of instability.

For this review, SLOPE/W was used to investigate one normal pool elevation and one PMF pool elevation:

- Current normal pool level of 485 feet.
- PMF pool level of 501.4 feet, applied as a surcharge load within SLOPE/W.

Using the drained and undrained strength parameters listed in Table 12, the existing dam was analyzed at the three critical cross sections selected for the CCR review. The undrained shear strength parameters were used in the seismic analyses.

A summary of the factors of safety are presented in Table 14 at the end of this section and printouts of the GeoStudio runs are presented in Appendix I.

Table 13 Summary of Computed Factors of Safety for the West Boiler Slag Pond Dam, 2015 CCR Mandate

Headwater Pool	Drainage	Incipient Motion	Seismic Load Case	Acceptance Criteria	Factor of Safety		
					A-A'	B-B'	C-C'
Normal Pool Elevation (448 feet)	Drained	Downstream	No	1.50	2.30	2.44	2.30
Normal Pool Elevation (448 feet)		Upstream		1.50	1.88	1.63	2.73
50% PMF Elevation(462.8 feet)		Downstream		1.40	2.30	2.44	2.18
50% PMF Elevation (462.8 feet)		Upstream		1.40	2.13	1.95	3.88
Normal Pool Elevation (448 feet)	Undrained	Downstream	Yes	1.00	1.35	1.30	1.53
Normal Pool Elevation (448 feet)		Upstream		1.00	1.34	1.30	2.25

Table 14 Summary of Computed Factors of Safety for the Landfill Runoff Collection Pond Dam, 2015 CCR Mandate

Headwater Pool	Drainage	Incipient Motion	Seismic Load Case	Acceptance Criteria	Factor of Safety	
					D-D'	E-E'
Normal Pool Elevation (485 feet)	Drained	Downstream	No	1.50	1.85	1.99
Normal Pool Elevation (485 feet)		Upstream		1.50	2.73	3.51
PMF Elevation Surcharge (501.4 feet)		Downstream		1.40	1.81	1.99
PMF Elevation Surcharge (501.4 feet)		Upstream		1.40	3.47	4.51
Normal Pool Elevation (485 feet)	Undrained	Downstream	Yes	1.00	1.42	1.64
Normal Pool Elevation (485 feet)		Upstream		1.00	1.94	2.28

7.0 CONCLUSIONS

7.1 PE CERTIFICATION

I, Stan Harris, being a Professional Engineer in good standing in the State of Indiana, do hereby certify, to the best of my knowledge, information, and belief that the information contained in this certification is prepared in accordance with the accepted practice of engineering. I certify that pursuant to 40 CFR 257.73(e)(2), the safety factor assessment for the AEP Clifty Creek Power Plant's Boiler Slag Pond Dam and Landfill Runoff Collection Pond demonstrates compliance with the factors of safety specified in 40 CFR 257.73(e)(1)(i) through (iv).

SIGNATURE Stan A. Harris DATE 2/16/16

STAN A. HARRIS REGISTERED No. PE-19700160 STATE OF INDIANA PROFESSIONAL ENGINEER

ADDRESS: Stantec Consulting Services Inc.
11687 Lebanon Road
Cincinnati, Ohio 45241-2012

TELEPHONE: (513) 842-8200

7.2 GENERAL

The analyses presented herein are based on information gathered (from various sources) using that degree of care and skill ordinarily exercised under similar circumstances by competent members of the engineering profession. Subsurface profiles are generally based on straight-line interpolation between borings and no warranties can be made regarding the continuity of subsurface conditions between the borings.

The boring logs and related information presented in this report depict approximate subsurface conditions only at the specific boring locations noted and at the time of drilling. Conditions at other locations may differ from those occurring at the boring locations. This report may require updating to reflect the different, modified facility specifics and/or the altered site conditions.

8.0 REFERENCES

1. Stantec, Report of Geotechnical Exploration, AEP Clifty Creek Power Landfill Runoff Collection Pond, May 2010

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3. Stantec, Reservoir Routing Analysis Landfill Runoff Collection Ash Pond Report, February 2010

4. Applied Geology and Environmental Sciences, Inc (AGES), "Hydrogeologic Study Report, Clifty Creek Coal Ash Landfill, Clifty Creek Station," Report Date: November, 2006

5. ASCE, Foundation Engineering Handbook, Design and Construction with the 2006 International Building Code, Robert W. Day, 2005

6. Earthquake Engineering Research Center, Recent Advances in Soils Liquefaction Engineering: A Unified and Consistent Framework, R.B. Seed, K.O. Cetin, R.E.S Moss, A.M. Kammerer, J. Wu, J.M. Pestana, M.F. Riemer, R.B. Sancio, J.D. Bray, R.E. Kayen, A. Faris, 2003

7. USACE, EM 1110-2-1902 Engineering and Design - Slope Stability, 2003

8. Indiana Department of Natural Resources, General Guidelines for New Dams and Improvements to Existing Dams in Indiana, 2001

9. Virginia Polytechnic Institute and State University, Virginia Tech Center For Geotechnical Practice and Research, Performance and Use of the Standard Penetration Test in Geotechnical Engineering Practice October 1998

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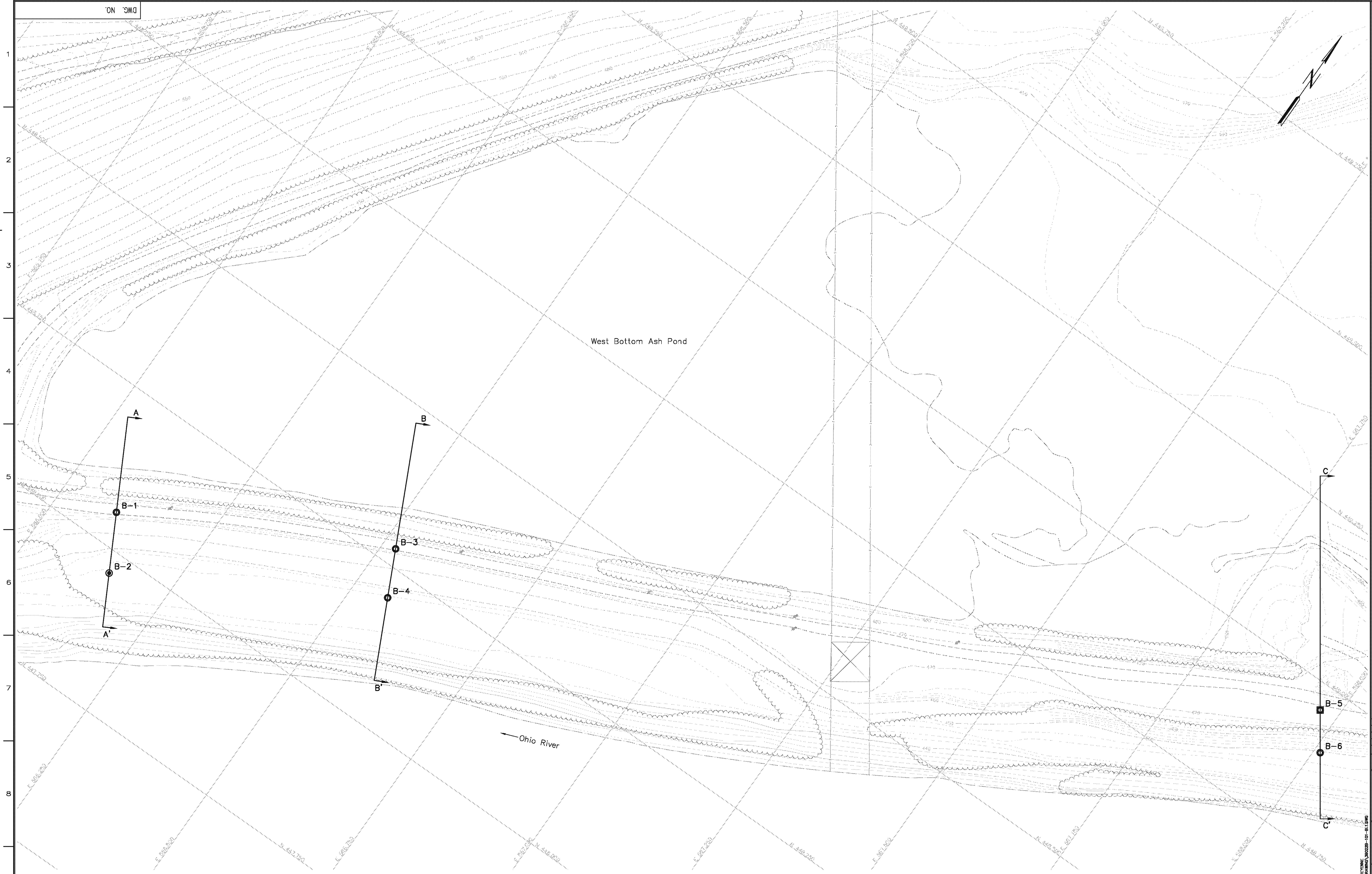
11. Indiana-Kentucky Electric Corporation, (IKEC), "Flyash Dam Raising Feasibility Report, Clifty Creek Plant," Report Date: January 31, 1985

12. US Department of the Interior, Bureau of Reclamation, Design of Small Dams, Second Edition, 1973

APPENDIX A

SITE PLANS

BOILER SLAG POND DAM



BORING LAYOUT
SCALE: 1"=60'

30 0 60 120 FEET
GRAPHIC SCALE

LEGEND

- Soil Boring with Undisturbed (Shelby) Tube Samples and/or Standard Penetration Tests
- Soil Boring with Undisturbed (Shelby) Tube Samples and/or Standard Penetration Tests and Rock Core

NOTES

REFERENCE DRAWINGS

DATE	NO.	DESCRIPTION	APPD.

REVISIONS

INDIANA – KENTUCKY ELECTRIC CO.

CLIFTY CREEK PLANT

MADISON INDIANA

GEOTECHNICAL EXPLORATION WEST BOTTOM ASH POND BORING LAYOUT

DWG. NO.

SCALE:	CIVIL ENGINEERING DIVISION
DR:	APPROVED BY
CH:	
ARCH:	
ENGR:	
DATE:	

AEP SERVICE CORP.
1 RIVERSIDE PLAZA
COLUMBUS, OH 43215

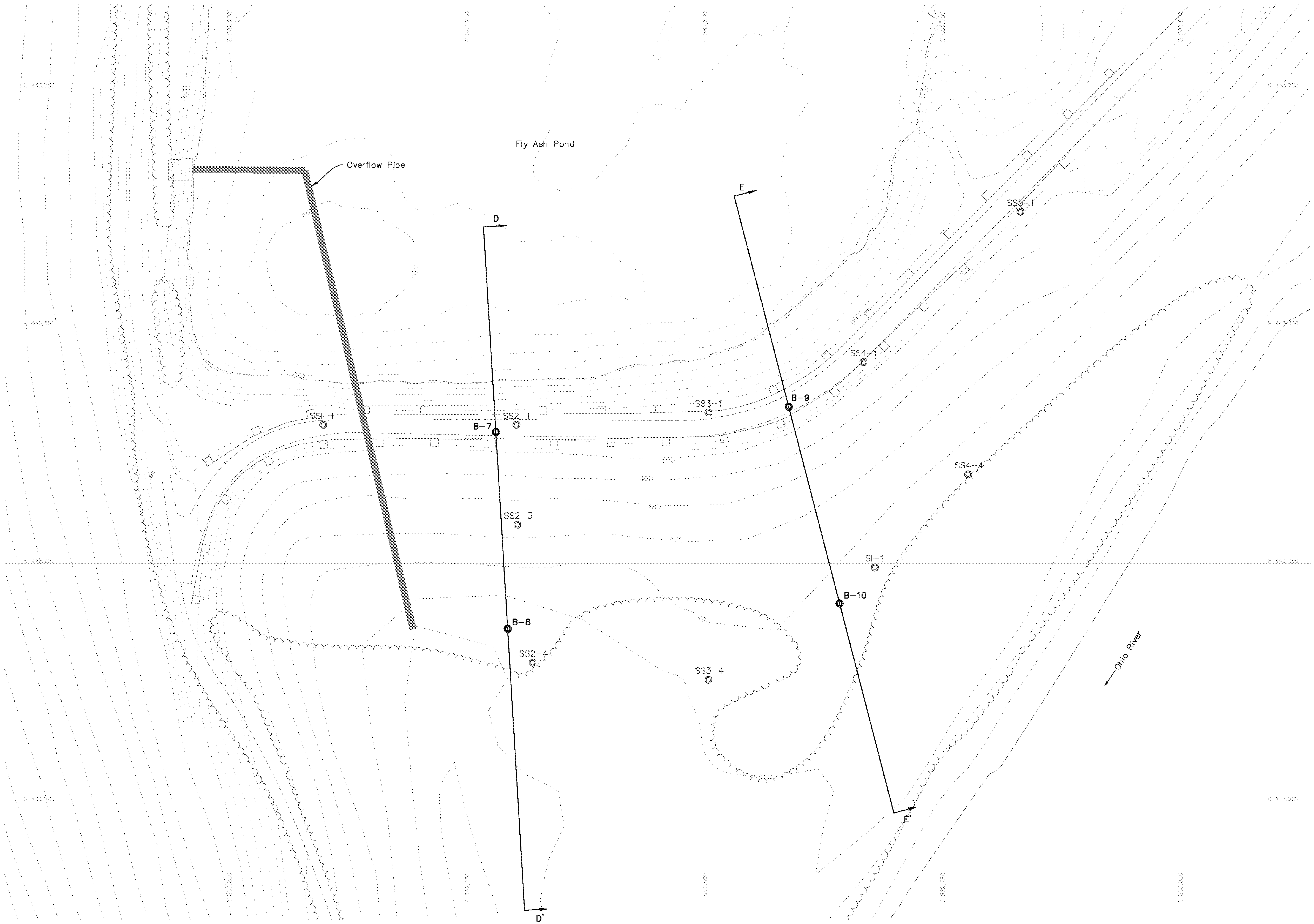
SCALE:	AS SHOWN
DR:	CW
CH:	EMK
ENGR:	CN
DATE:	APR., 2010

Stantec

Stantec Consulting Services Inc.
11687 Lebanon Rd.
Cincinnati, Ohio
45241
513-842-8200
www.stantec.com

PLOT DATE: 04/12/2010 USER: WITHERS, CHEYENNE
V:\1755\ACTIVE\175539022\GEOTECHNICAL\DRAWING\39022B-101-BL1.DWG

LANDFILL RUNOFF COLLECTION POND



BORING LAYOUT
SCALE: 1"=40'

20 0 40 80 FEET
GRAPHIC SCALE

LEGEND

- Soil Boring with Undisturbed (Shelby) Tube Samples and/or Standard Penetration Tests
- Historic Boring

NOTES

REFERENCE DRAWINGS

DATE	NO.	DESCRIPTION	APPD.

REVISIONS

INDIANA – KENTUCKY ELECTRIC CO.
CLIFTY CREEK PLANT
MADISON INDIANA

GEOTECHNICAL EXPLORATION
LANDFILL RUNOFF
COLLECTION POND DAM
BORING LAYOUT

DWG. NO.

SCALE: | CIVIL ENGINEERING DIVISION
DR:
CH:
ARCH:
ENGR:
DATE:
APPROVED BY

PLOT DATE: 05/20/2010 USER: WITHERS, CHEYENNE
V:\1755\ACTIVE\175539022\GEOTECHNICAL\DRAWING\39022B-102-BL2.DWG

SCALE: AS SHOWN
DR: CW
CH: EMK
ENGR: CN
DATE: MAY, 2010

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AMERICAN ELECTRIC POWER
AEP SERVICE CORP.
1 RIVERSIDE PLAZA
COLUMBUS, OH 43215

APPENDIX B

BORING LOGS

BOILER SLAG POND DAM

Stantec

SUBSURFACE LOG

Project Number	175539022	Location	West Crest: West Pond Dam
Project Name	AEP Clifty Creek / Ash Ponds	Boring No.	**B-1** Total Depth 71.5 ft
County	Jefferson, IN	Surface Elevation	473.4 ft
Project Type	Geotechnical Exploration	Date Started	11/3/09 Completed 11/4/09
Supervisor	C. Nisingizwe Driller M. Wethington	Depth to Water	40.0 ft Date/Time 11/4/09
Logged By	C. Nisingizwe	Depth to Water	39.2 ft Date/Time 11/13/09

Lithology			Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	
Elevation	Depth	Description	Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	Remarks
473.4'	0.0'	Top of Hole							
		Lean Clay With Sand, light yellowish brown with light gray, damp to moist, medium stiff to very stiff, Fill		SPT-1	2.5 - 4.0	1.2	6-5-6	17	N = 11
				SPT-2	5.0 - 6.5	1.3	5-5-5	15	N = 10
				ST-3	7.5 - 9.5	2.0		23	
				SPT-4	10.0 - 11.5	0.4	1-5-5	21	N = 10
				SPT-5	12.5 - 14.0	1.3	2-2-5	17	N = 7
				ST-6	15.0 - 17.0	2.0		20	
				SPT-7	17.5 - 19.0	1.5	5-6-9	19	N = 15
				SPT-8	20.0 - 21.5	1.5	3-5-10	15	N = 15
				SPT-9	22.5 - 24.0	1.5	3-7-7	17	N = 14
				SPT-10	25.0 - 26.5	1.2	3-3-5	17	N = 8
				SPT-11	27.5 - 29.0	1.3	3-4-8	20	N = 12
				SPT-12	30.0 - 31.5	1.4	4-4-7	19	N = 11
				SPT-13	32.5 - 34.0	1.3	2-4-5	18	N = 9
				SPT-14	35.0 - 36.5	1.1	2-5-5	17	N = 10
435.9'	37.5'								
				SPT-15	37.5 - 39.0	1.2	1-2-4	20	N = 6

STANTEC/FMSM_LEGACY 175539022 CLIFTY CREEK.GPJ FMSM-GRAPHIC LOG.GDT 5/20/10

Stantec

SUBSURFACE LOG

Project Number	175539022	Location	West Crest: West Pond Dam		
Project Name	AEP Clifty Creek / Ash Ponds	Boring No.	**B-1**	Total Depth	71.5 ft

Lithology			Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	
Elevation	Depth	Description	Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	Remarks
		Lean Clay With Sand, light yellowish brown with light gray, moist to wet, very soft to medium stiff *(Continued)*		SPT-16	40.0 - 41.5	1.3	1-2-3	24	N = 5
				ST-17	42.5 - 44.5	2.0		22	
				SPT-18	45.0 - 46.5	1.5	1-1-1	30	N = 2
				SPT-19	47.5 - 49.0	1.5	1-1-2	23	N = 3
				SPT-20	50.0 - 51.5	1.1	1-1-3	28	N = 4
				SPT-21	52.5 - 54.0	1.5	1-1-1	27	N = 2
				SPT-22	55.0 - 56.5	1.5	1-2-2	25	N = 4
				SPT-23	57.5 - 59.0	1.1	1-1-3	28	N = 4
				SPT-24	60.0 - 61.5	1.4	1-2-3	28	N = 5
				SPT-25	62.5 - 64.0	1.3	1-2-4	37	N = 6
				SPT-26	65.0 - 66.5	1.2	2-2-5	34	N = 7
405.9'	67.5'								
		Gray, Weathered Shale, Augered		SPT-27	67.5 - 69.0	0.4	50+	14	50+
401.9'	71.5'			SPT-28	70.0 - 71.5	0.3	50+	5	50+
		No Refusal / Bottom of Hole							

Stantec

SUBSURFACE LOG

Project Number	175539022	Location	West Toe: West Pond Dam
Project Name	AEP Clifty Creek / Ash Ponds	Boring No.	**B-2** Total Depth 61.0 ft
County	Jefferson, IN	Surface Elevation	444.0 ft
Project Type	Geotechnical Exploration	Date Started	11/12/09 Completed 11/12/09
Supervisor	C. Nisingizwe Driller M. Wethington	Depth to Water	22.5 ft Date/Time 11/12/09
Logged By	C. Nisingizwe	Depth to Water	N/A Date/Time N/A

Lithology Elevation	Lithology Depth	Description	Overburden / Rock Core	Sample # / RQD	Depth / Run	Rec. Ft. / Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
444.0'	0.0'	Top of Hole							
		Lean Clay With Sand, light yellowish brown with gray, moist to wet, soft to very stiff		SPT-1	2.5 - 4.0	1.2	7-8-11	17	N = 19
				SPT-2	5.0 - 6.5	0.6	4-3-4	19	N = 7
				SPT-3	7.5 - 9.0	0.6	3-3-4	24	N = 7
				ST-4	10.0 - 12.0	1.6		22	
				SPT-5	12.5 - 14.0	1.2	2-2-3	25	N = 5
				SPT-6	15.0 - 16.5	1.2	2-2-2	28	N = 4
				SPT-7	17.5 - 19.0	1.5	1-1-1	30	N = 2
				SPT-8	20.0 - 21.5	1.5	1-2-2	32	N = 4
				ST-9	22.5 - 24.5	2.0		29	
				SPT-10	25.0 - 26.5	1.5	2-2-2	29	N = 4
				SPT-11	27.5 - 29.0	0.7	1-4-5	30	N = 9
414.0'	30.0'								
		Lean Clay With Sand, gray, moist to wet, soft to medium stiff		SPT-12	30.0 - 31.5	1.5	3-3-3	25	N = 6
				SPT-13	32.5 - 34.0	1.5	3-3-3	32	N = 6
				SPT-14	35.0 - 36.5	1.5	1-2-3	33	N = 5
				SPT-15	37.5 - 39.0	1.5	1-2-2	31	N = 4

STANTEC/FMSM_LEGACY 175539022 CLIFTY CREEK.GPJ FMSM-GRAPHIC LOG.GDT 5/20/10

Project Number	175539022	Location	West Toe: West Pond Dam
Project Name	AEP Clifty Creek / Ash Ponds	Boring No.	**B-2** Total Depth 61.0 ft

Lithology Elevation	Depth	Description	Overburden / Rock Core Sample # / RQD	Depth / Run	Rec. Ft. / Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
		Lean Clay With Sand, gray, moist to wet, soft to medium stiff *(Continued)*	SPT-16	40.0 - 41.5	1.5	3-3-3	30	N = 6
			ST-17	42.5 - 44.5	1.5		33	
			SPT-18	45.0 - 46.5	1.5	1-1-1	35	N = 2
392.5'	51.5'		SPT-19	50.0 - 51.5	1.5	4-3-3	33	N = 6
388.5'	55.5'	Gravel With Silt And Sand, gray, wet, very dense	SPT-20	55.0 - 55.5	0.4	11-50+	10	Began Core N = 50+
383.0'	61.0'	Shale, gray, hard, medium bedded	45	5.5	5.5	100	61.0	

Bottom of Hole

Top of Rock = 56.0'
Elevation (388.0')

Stantec

SUBSURFACE LOG

Project Number	175539022	Location	Middle Crest: West Pond Dam
Project Name	AEP Clifty Creek / Ash Ponds	Boring No.	**B-3** Total Depth 71.5 ft
County	Jefferson, IN	Surface Elevation	471.6 ft
Project Type	Geotechnical Exploration	Date Started	11/4/09 Completed 11/5/09
Supervisor	C. Nisingizwe Driller M. Wethington	Depth to Water	40.0 ft Date/Time 11/4/09
Logged By	C. Nisingizwe	Depth to Water	31.0 ft Date/Time 11/13/09

Lithology			Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	
Elevation	Depth	Description	Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	Remarks
471.6'	0.0'	Top of Hole							
		Lean Clay With Sand, light yellowish brown with light gray, damp to moist, stiff to very stiff, Fill		SPT-1	2.5 - 4.0	0.7	4-5-6	15	N = 11
				SPT-2	5.0 - 6.5	1.1	3-4-4	17	N = 8
				SPT-3	7.5 - 9.0	1.1	3-3-7	16	N = 10
				ST-4	10.0 - 12.0	2.0		16	
				SPT-5	12.5 - 14.0	1.5	4-4-5	22	N = 9
				SPT-6	15.0 - 16.5	1.0	3-4-6	17	N = 10
				SPT-7	17.5 - 19.0	1.3	3-5-7	18	N = 12
				ST-8	20.0 - 22.0	2.0		18	
				SPT-9	22.5 - 24.0	1.5	3-5-7	17	N = 12
				SPT-10	25.0 - 26.5	1.3	3-4-5	18	N = 9
				SPT-11	27.5 - 29.0	1.5	6-7-8	16	N = 15
				SPT-12	30.0 - 31.5	1.5	5-5-5	18	N = 10
				SPT-13	32.5 - 34.0	1.5	4-7-10	17	N = 17
				SPT-14	35.0 - 36.5	1.5	5-7-9	22	N = 16
434.1'	37.5'								
				SPT-15	37.5 - 39.0	1.5	5-7-11	20	N = 18

STANTEC/FMSM_LEGACY 175539022 CLIFTY CREEK.GPJ FMSM-GRAPHIC LOG.GDT 5/20/10

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SUBSURFACE LOG

Project Number	175539022	Location	Middle Crest: West Pond Dam		
Project Name	AEP Clifty Creek / Ash Ponds	Boring No.	B-3	Total Depth	71.5 ft

Lithology			Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	
Elevation	Depth	Description	Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	Remarks
		Lean Clay With Sand, gray to light brown, moist to wet, very stiff to very stiff *(Continued)*		SPT-16	40.0 - 41.5	1.5	1-2-2	24	N = 4
				SPT-17	42.5 - 44.0	1.5	1-2-2	23	N = 4
				SPT-18	45.0 - 46.5	1.3	2-3-3	25	N = 6
				ST-19	47.5 - 49.5	2.0		23	
				SPT-20	50.0 - 51.5	1.5	1-2-2	25	N = 4
				SPT-21	52.5 - 54.0	1.5	1-1-1	25	N = 2
				SPT-22	55.0 - 56.5	1.5	1-2-3	24	N = 5
				SPT-23	57.5 - 59.0	1.5	1-1-1	40	N = 2
				SPT-24	60.0 - 61.5	1.5	3-4-4	28	N = 8
				SPT-25	62.5 - 64.0	1.5	1-2-4	33	N = 6
				SPT-26	65.0 - 66.5	1.5	1-3-4	34	N = 7
				SPT-27	67.5 - 69.0	1.5	2-4-5	29	N = 9
400.1'	71.5'			SPT-28	70.0 - 71.5	1.5	3-3-5	31	N = 8
		No Refusal / Bottom of Hole							

STANTEC/FMSM_LEGACY 175539022 CLIFTY CREEK.GPJ FMSM-GRAPHIC LOG.GDT 5/20/10

Project Number	175539022	Location	Middle Toe: West Pond Dam		
Project Name	AEP Clifty Creek / Ash Ponds	Boring No.	**B-4**	Total Depth	71.5 ft
County	Jefferson, IN	Surface Elevation	444.0 ft		
Project Type	Geotechnical Exploration	Date Started	11/10/09	Completed	11/11/09
Supervisor	C. Nisingizwe Driller M. Wethington	Depth to Water	22.5 ft	Date/Time	11/10/09
Logged By	C. Nisingizwe	Depth to Water	16.0 ft	Date/Time	11/13/09

Lithology Elevation	Lithology Depth	Description	Overburden / Rock Core	Sample # / RQD	Depth / Run	Rec. Ft. / Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
444.0'	0.0'	Top of Hole							
		Lean Clay With Sand, brown to dark gray, damp to moist, medium stiff to very stiff		SPT-1	2.5 - 4.0	1.3	8-8-8	14	N = 16
				SPT-2	5.0 - 6.5	1.4	6-7-8	16	N = 15
				ST-3	7.5 - 9.5	2.0		--	
				SPT-4	10.0 - 11.5	1.3	3-5-6	19	N = 11
				SPT-5	12.5 - 14.0	1.0	2-3-4	22	N = 7
429.0'	15.0'	Lean Clay With Sand, gray, moist to wet, soft to stiff		SPT-6	15.0 - 16.5	1.2	2-2-3	26	N = 5
				ST-7	17.5 - 19.5	2.0		--	
				SPT-8	20.0 - 21.5	1.5	2-2-2	26	N = 4
				SPT-9	22.5 - 24.0	1.5	1-2-3	27	N = 5
				SPT-10	25.0 - 26.5	1.5	2-2-4	26	N = 6
				SPT-11	27.5 - 29.0	1.5	1-2-3	27	N = 5
				SPT-12	30.0 - 31.5	1.5	1-1-2	28	N = 3
				SPT-13	32.5 - 34.0	1.5	1-2-2	35	N = 4
				SPT-14	35.0 - 36.5	1.5	2-4-5	31	N = 9
				ST-15	37.5 - 39.5	2.0		--	

Project Number	175539022	Location	Middle Toe: West Pond Dam
Project Name	AEP Clifty Creek / Ash Ponds	Boring No.	**B-4**
		Total Depth	71.5 ft

Lithology			Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	
Elevation	Depth	Description	Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	Remarks
		Lean Clay With Sand, gray, moist to wet, soft to stiff *(Continued)*		SPT-16	40.0 - 41.5	1.5	2-2-2	24	N = 4
				SPT-17	42.5 - 44.0	1.2	1-2-3	33	N = 5
				SPT-18	45.0 - 46.5	1.5	2-4-4	35	N = 8
				SPT-19	47.5 - 49.0	1.2	1-2-4	31	N = 6
				SPT-20	50.0 - 51.5	1.5	2-3-4	31	N = 7
				SPT-21	52.5 - 54.0	1.5	1-2-3	30	N = 5
				SPT-22	55.0 - 56.5	1.5	2-3-4	21	N = 7
386.5'	57.5'								
		Gravel With Silt And Sand, gray, moist, dense to very dense		SPT-23	57.5 - 59.0	1.5	10-17-22	13	N = 39
				SPT-24	60.0 - 61.5	1.5	16-28-18	9	N = 46
				SPT-25	65.0 - 66.5	0.7	26-50+	12	N = 50+
372.5'	71.5'			SPT-26	70.0 - 71.5	0.7	20-22-30	9	N = 52
		No Refusal / Bottom of Hole							

STANTEC/FMSM_LEGACY 175539022 CLIFTY CREEK.GPJ FMSM-GRAPHIC LOG.GDT 5/20/10

Project Number	175539022	Location	East Crest: West Pond Dam
Project Name	AEP Clifty Creek / Ash Ponds	Boring No.	**B-5** Total Depth 71.5 ft
County	Jefferson, IN	Surface Elevation	468.7 ft
Project Type	Geotechnical Exploration	Date Started	11/10/09 Completed 11/10/09
Supervisor	C. Nisingizwe Driller M. Wethington	Depth to Water	45.0 ft Date/Time 11/10/09
Logged By	C. Nisingizwe	Depth to Water	33.8 ft Date/Time 11/13/09

Lithology Elevation	Depth	Description	Overburden / Rock Core	Sample # / RQD	Depth / Run	Rec. Ft. / Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
468.7'	0.0'	Top of Hole							
		Lean Clay With Sand, light yellowish brown with light gray, damp to moist, medium stiff to very stiff, Fill		SPT-1	2.5 - 4.0	1.5	6-9-10	15	N = 19
				SPT-2	5.0 - 6.5	1.5	4-4-5	17	N = 9
				ST-3	7.5 - 9.5	1.6		17	
				SPT-4	10.0 - 11.5	1.3	6-7-8	23	N = 15
				SPT-5	12.5 - 14.0	0.0	3-4-6	--	N = 10
				SPT-6	15.0 - 16.5	1.3	1-3-4	16	N = 7
				SPT-7	17.5 - 19.0	1.0	5-7-9	16	N = 16
				SPT-8	20.0 - 21.5	0.6	1-2-5	18	N = 7
				ST-9	22.5 - 24.5	1.8		19	
				SPT-10	25.0 - 26.5	1.2	2-3-5	22	N = 8
				SPT-11	27.5 - 29.0	1.4	1-2-5	25	N = 7
				SPT-12	30.0 - 31.5	1.3	4-5-7	23	N = 12
				SPT-13	32.5 - 34.0	1.5	2-3-5	19	N = 8
432.2'	36.5'			SPT-14	35.0 - 36.5	1.5	4-6-10	18	N = 16
		Lean Clay With Sand, gray, moist, soft		SPT-15	37.5 - 39.0	1.5	2-3-3	21	N = 6

STANTEC/FMSM_LEGACY 175539022 CLIFTY CREEK.GPJ FMSM-GRAPHIC LOG.GDT 5/20/10

Project Number	175539022	Location	East Crest: West Pond Dam		
Project Name	AEP Clifty Creek / Ash Ponds	Boring No.	**B-5**	Total Depth	71.5 ft

Lithology			Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	
Elevation	Depth	Description	Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	Remarks
		Lean Clay With Sand, gray, moist, soft *(Continued)*		SPT-16	40.0 - 41.5	1.3	1-1-2	25	N = 3
				ST-17	42.5 - 44.5	2.0		23	
				SPT-18	45.0 - 46.5	1.5	1-1-3	25	N = 4
421.2'	47.5'								
		Sandy Silt, light yellowish brown to gray, wet, soft to stiff		SPT-19	47.5 - 49.0	1.5	1-1-3	28	N = 4
				SPT-20	50.0 - 51.5	1.5	1-1-5	24	N = 6
				SPT-21	52.5 - 54.0	1.0	1-1-1	22	N = 2
				SPT-22	55.0 - 56.5	1.3	1-2-2	23	N = 4
				SPT-23	57.5 - 59.0	1.5	1-2-3	26	N = 5
				SPT-24	60.0 - 61.5	1.5	2-3-4	22	N = 7
				SPT-25	62.5 - 64.0	1.5	2-3-6	27	N = 9
				SPT-26	65.0 - 66.5	1.5	2-5-6	28	N = 11
				SPT-27	67.5 - 69.0	1.5	2-4-5	28	N = 9
397.2'	71.5'			SPT-28	70.0 - 71.5	1.5	3-5-8	30	N = 13
		No Refusal / Bottom of Hole							

Project Number	175539022	Location	East Toe: West Pond Dam
Project Name	AEP Clifty Creek / Ash Ponds	Boring No.	**B-6** Total Depth 71.5 ft
County	Jefferson, IN	Surface Elevation	445.5 ft
Project Type	Geotechnical Exploration	Date Started	11/19/09 Completed 11/19/09
Supervisor	C. Nisingizwe Driller Danny Jessie	Depth to Water	30.0 ft Date/Time 11/19/09
Logged By	C. Nisingizwe	Depth to Water	N/A Date/Time N/A

Lithology Elevation	Lithology Depth	Description	Overburden / Rock Core	Sample # / RQD	Depth / Run	Rec. Ft. / Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
445.5'	0.0'	Top of Hole							
		Lean Clay With Sand, brown to gray, damp to moist, stiff to very stiff							
				SPT-1	2.5 - 4.0	1.0	2-4-4	19	N = 8
				SPT-2	5.0 - 6.5	1.0	4-4-6	18	N = 10
				ST-3	7.5 - 9.5	2.0		25	
				SPT-4	10.0 - 11.5	1.2	5-7-11	16	N = 18
				SPT-5	12.5 - 14.0	1.1	2-2-2	21	N = 4
				SPT-6	15.0 - 16.5	1.3	1-1-2	31	N = 3
				ST-7	17.5 - 19.5	1.2		32	
				SPT-8	20.0 - 21.5	1.5	0-1-0	32	N = 1
				SPT-9	22.5 - 24.0	1.5	0-0-2	29	N = 2
				SPT-10	25.0 - 26.5	1.5	2-1-3	29	N = 4
418.0'	27.5'								
		Sandy Silt, gray, moist to wet, very soft to stiff		SPT-11	27.5 - 29.0	1.5	0-3-2	32	N = 5
				SPT-12	30.0 - 31.5	1.5	0-0-3	32	N = 3
				SPT-13	32.5 - 34.0	1.5	0-1-2	33	N = 3
				SPT-14	35.0 - 36.5	1.5	0-0-1	35	N = 1
				SPT-15	37.5 - 39.0	1.5	0-0-1	30	N = 1

STANTEC/FMSM_LEGACY 175539022 CLIFTY CREEK.GPJ FMSM-GRAPHIC LOG.GDT 5/20/10

SUBSURFACE LOG

Project Number	175539022	Location	East Toe: West Pond Dam		
Project Name	AEP Clifty Creek / Ash Ponds	Boring No.	**B-6**	Total Depth	71.5 ft

Lithology			Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	
Elevation	Depth	Description	Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	Remarks
		Sandy Silt, gray, moist to wet, very soft to stiff *(Continued)*		ST-16	40.0 - 42.0	1.1		31	
				SPT-17	42.5 - 44.0	1.5	0-1-1	35	N = 2
				SPT-18	45.0 - 46.5	1.5	0-0-1	40	N = 1
				SPT-19	47.5 - 49.0	1.5	0-0-1	40	N = 1
				SPT-20	50.0 - 51.5	1.5	0-2-3	39	N = 5
				SPT-21	52.5 - 54.0	1.5	0-5-6	27	N = 11
				SPT-22	55.0 - 56.5	1.5	4-3-4	31	N = 7
				SPT-23	57.5 - 59.0	1.5	4-4-5	35	N = 9
				SPT-24	60.0 - 61.5	1.5	5-5-6	28	N = 11
				SPT-25	65.0 - 66.5	1.5	4-5-4	28	N = 9
374.0'	71.5'			SPT-26	70.0 - 71.5	0.0	5-5-5	--	N = 10
		No Refusal / Bottom of Hole							

STANTEC/FMSM_LEGACY 175539022 CLIFTY CREEK.GPJ FMSM-GRAPHIC LOG.GDT 5/20/10

LANDFILL RUNOFF COLLECTION POND:
2009 GEOTECHNICAL EXPLORATION

Stantec

SUBSURFACE LOG

Project Number	175539022	Location	Crest: LRCP Dam		
Project Name	AEP Clifty Creek / Ash Ponds	Boring No.	**B-7**	Total Depth	29.0 ft
County	Jefferson, IN	Surface Elevation	503.4 ft		
Project Type	Geotechnical Exploration	Date Started	11/12/09	Completed	11/12/09
Supervisor	C. Nisingizwe Driller M. Wethington	Depth to Water	Dry	Date/Time	11/12/09
Logged By	C. Nisingizwe	Depth to Water	N/A	Date/Time	N/A

Lithology			Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	
Elevation	Depth	Description	Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	Remarks
503.4'	0.0'	Top of Hole							
502.9'	0.5'	Asphalt pavement and gravel base							
		Lean Clay, yellow and light gray, moist, stiff							
				ST-1	23.0 - 25.0	2.0		--	
				ST-2	25.0 - 27.0	2.0		20	
474.4'	29.0'			ST-3	27.0 - 29.0	2.0		20	
		No Refusal / Bottom of Hole							

STANTEC/FMSM_LEGACY 175539022 CLIFTY CREEK.GPJ FMSM-GRAPHIC LOG.GDT 4/16/10

4/16/10

Stantec

SUBSURFACE LOG

Project Number	175539022	Location	Toe: LRCP Dam
Project Name	AEP Clifty Creek / Ash Ponds	Boring No.	**B-8**
		Total Depth	31.0 ft
County	Jefferson, IN	Surface Elevation	441.5 ft
Project Type	Geotechnical Exploration	Date Started	11/19/09
		Completed	11/19/09
Supervisor	C. Nisingizwe	Driller	Danny Jessie
Depth to Water	Dry	Date/Time	11/19/09
Logged By	C. Nisingizwe		
Depth to Water	N/A	Date/Time	N/A

Lithology			Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	
Elevation	Depth	Description	Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	Remarks
441.5'	0.0'	Top of Hole							
		Silty Clay, yellow and light gray, damp to moist							
425.5'	16.0'								
		Lean Clay, yellowish brown and light gray, moist		ST-1	25.0 - 27.0	2.0		25	
				ST-2	27.0 - 29.0	2.0		26	
412.5'	29.0'								
		Lean Clay With Sand, yellowish brown and light gray, moist		ST-3	29.0 - 31.0	2.0		23	
410.5'	31.0'	No Refusal / Bottom of Hole							

STANTEC/FMSM_LEGACY 175539022 CLIFTY CREEK.GPJ FMSM-GRAPHIC LOG.GDT 4/16/10

SUBSURFACE LOG

Project Number	175539022	Location	Crest: LRCP Dam		
Project Name	AEP Clifty Creek / Ash Ponds	Boring No.	**B-9**	Total Depth	22.0 ft
County	Jefferson, IN	Surface Elevation	504.3 ft		
Project Type	Geotechnical Exploration	Date Started	11/12/09	Completed	11/12/09
Supervisor	C. Nisingizwe Driller M. Wethington	Depth to Water	Dry	Date/Time	11/12/09
Logged By	C. Nisingizwe	Depth to Water	N/A	Date/Time	N/A

Lithology			Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	
Elevation	Depth	Description	Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	Remarks
504.3'	0.0'	Top of Hole							
503.8'	0.5'	Asphalt pavement and gravel base							
		Lean Clay, yellowish brown and light gray, damp to moist							
				ST-1	16.0 - 18.0	2.0		22	
				ST-2	18.0 - 20.0	2.0		19	
482.3'	22.0'			ST-3	20.0 - 22.0	2.0		20	
		No Refusal / Bottom of Hole							

STANTEC/FMSM_LEGACY 175539022 CLIFTY CREEK.GPJ FMSM-GRAPHIC LOG.GDT 4/16/10

4/16/10

Stantec

SUBSURFACE LOG

Project Number	175539022	Location	Toe: LRCP Dam
Project Name	AEP Clifty Creek / Ash Ponds	Boring No.	**B-10** Total Depth 18.0 ft
County	Jefferson, IN	Surface Elevation	457.3 ft
Project Type	Geotechnical Exploration	Date Started	11/19/09 Completed 11/19/07
Supervisor	C. Nisingizwe Driller Danny Jessie	Depth to Water	Dry Date/Time 11/19/07
Logged By	C. Nisingizwe	Depth to Water	N/A Date/Time N/A

Lithology Elevation	Lithology Depth	Description	Overburden / Rock Core	Sample # / RQD	Depth / Run	Rec. Ft. / Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
457.3'	0.0'	Top of Hole							
		Silty Clay With Sand, yellow and light gray, damp to moist							
444.1'	13.2'			ST-1	12.0 - 14.0	1.5		17	
		Silty Sand, gray to brown, damp to moist		ST-2	14.0 - 16.0	2.0		10	
441.3'	16.0'								
		Silty Clay With Sand, yellow and light gray, damp to moist		ST-3	16.0 - 18.0	2.0		25	
439.3'	18.0'								
		No Refusal / Bottom of Hole							

STANTEC/FMSM_LEGACY 175539022 CLIFTY CREEK.GPJ FMSM-GRAPHIC LOG.GDT 4/16/10

LANDFILL RUNOFF COLLECTION POND:
2015 GEOTECHNICAL EXPLORATION

Stantec

SUBSURFACE LOG

Project Number	175553022	Location	Landfill Runoff Collection Pond Dam
Project Name	CCR Rule - AEP Clifty Creek	Boring No.	**B-12** Total Depth 101.5 ft
County	Jefferson, IN	Surface Elevation	503.9 (estimated)
Project Type	Geotechnical Exploration	Date Started	7/6/15 Completed 7/7/15
Supervisor	C. Nisingizwe Driller E. Caudill	Depth to Water	60.0 ft Date/Time 7/7/15
Logged By	C. Nisingizwe	Depth to Water	N/A Date/Time N/A

Lithology Elevation	Lithology Depth	Description	Overburden / Rock Core	Sample # / RQD	Depth / Run	Rec. Ft. / Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
503.9	0.0	Top of Hole							
(estimated)	0.4	Asphalt and base							
		Lean Clay With Sand, gray, damp, medium stiff to stiff		SPT-1	1.0 - 2.5	1.5	1-2-5	21	Pocket Penetrometer (PP) = 2.50 tsf
				SPT-2	5.0 - 6.5	1.5	3-3-4	20	PP = 2.50 tsf
				SPT-3	10.0 - 11.5	1.2	3-4-5	23	PP = 3.50 tsf
				SPT-4	15.0 - 16.5	1.0	3-3-5	19	PP = 2.50 tsf
				SPT-5	20.0 - 21.5	0.9	4-6-9	18	PP = 2.50 tsf
				SPT-6	25.0 - 26.5	1.1	3-5-7	18	PP = 4.25 tsf
				SPT-7	30.0 - 31.5	1.3	2-5-8	19	PP = 4.50 tsf
				SPT-8	35.0 - 36.5	0.9	WOH-3-4	18	PP = 4.00 tsf

STANTEC/FMSM_LEGACY GINT LOG.GPJ FMSM GRAPHIC LOG.GDT 8/6/15

Project Number	175553022	Location	Landfill Runoff Collection Pond Dam		
Project Name	CCR Rule - AEP Clifty Creek	Boring No.	**B-12**	Total Depth	101.5 ft

Lithology Elevation	Lithology Depth	Description	Overburden / Rock Core	Sample # / RQD	Depth / Run	Rec. Ft. / Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
	40.0	Lean Clay With Sand, gray, damp, medium stiff to stiff *(Continued)*							
	50.0	Silty Clay With Sand, brown, moist, medium stiff to very stiff		SPT-9	40.0 - 41.5	1.5	6-8-8	16	
				SPT-10	45.0 - 46.5	1.5	1-3-5	19	
	58.0	Silt With Sand, grayish light brown, moist, medium stiff to stiff		SPT-11	50.0 - 51.5	1.5	2-3-3	22	
				SPT-12	55.0 - 56.5	1.0	2-5-8	20	
	63.5	Silty Sand, grayish light brown, damp, very stiff		SPT-13	60.0 - 61.5	1.4	3-11-17	15	
	70.0	Silt With Sand, grayish light brown, wet, stiff		SPT-14	65.0 - 66.5	1.5	2-3-8	28	
	78.0	Sand, mottled gray and brown, moist to wet, medium stiff to stiff		SPT-15	70.0 - 71.5	1.5	3-5-5	22	
				SPT-16	75.0 - 76.5	1.3	2-3-5	28	

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SUBSURFACE LOG

Project Number	175553022	Location	Landfill Runoff Collection Pond Dam
Project Name	CCR Rule - AEP Clifty Creek	Boring No.	**B-12** Total Depth 101.5 ft

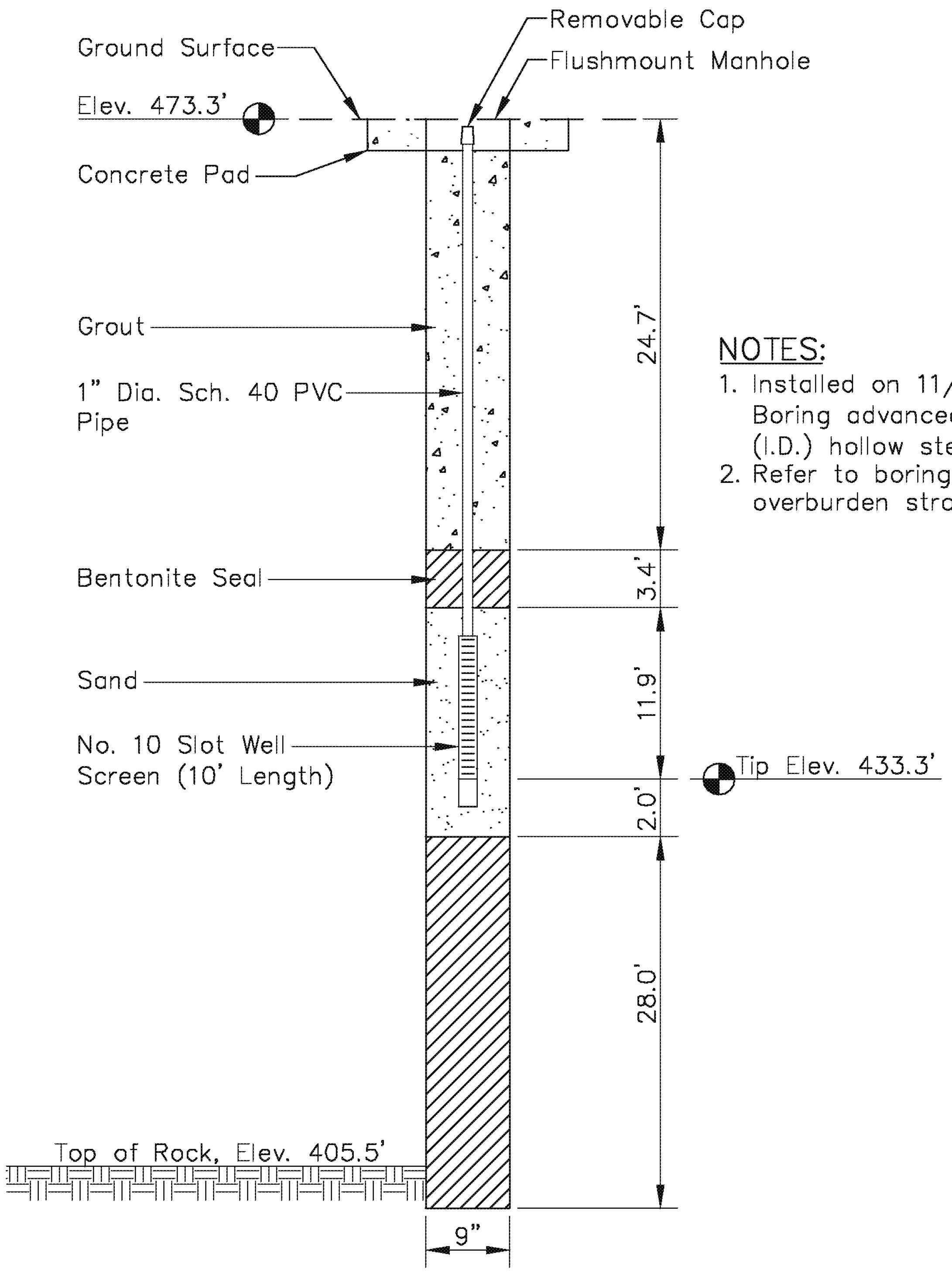
Lithology			Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	
Elevation	Depth	Description	Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	Remarks
		Silt, gray, moist to wet, medium stiff to stiff		SPT-17	80.0 - 81.5	1.5	6-9-6	26	
				SPT-18	85.0 - 86.5	1.5	2-3-5	28	
	90.0								
		Lean Clay, gray, moist, medium stiff to very stiff		SPT-19	90.0 - 91.5	1.5	2-4-4	25	PP = 2.25 tsf
				SPT-20	95.0 - 96.5	1.5	5-8-11	23	PP = 3.75 tsf
	101.5			SPT-21	100.0 - 101.5	1.5	4-6-8	27	PP = 3.50 tsf
		No Refusal / Bottom of Hole							

STANTEC/FMSM_LEGACY GINT LOG.GPJ FMSM GRAPHIC LOG.GDT 8/6/15

APPENDIX C

PIEZOMETER DETAILS

BOILER SLAG POND DAM



NOTES:
1. Installed on 11/04/2009. Boring advanced with 4.25" (I.D.) hollow stem augers.
2. Refer to boring log for overburden stratigraphy.

PLOT DATE: 02/18/2010 USER: JENNINGS, MATTHEW
V:\1755\ACTIVE\175539022\GEOTECHNICAL\DRAWING\INSTRUMENTS\PZB1.DWG

LOCATION:
Northing: 448,055.94
Easting: 566,098.09
Ground Elevation: 473.3'

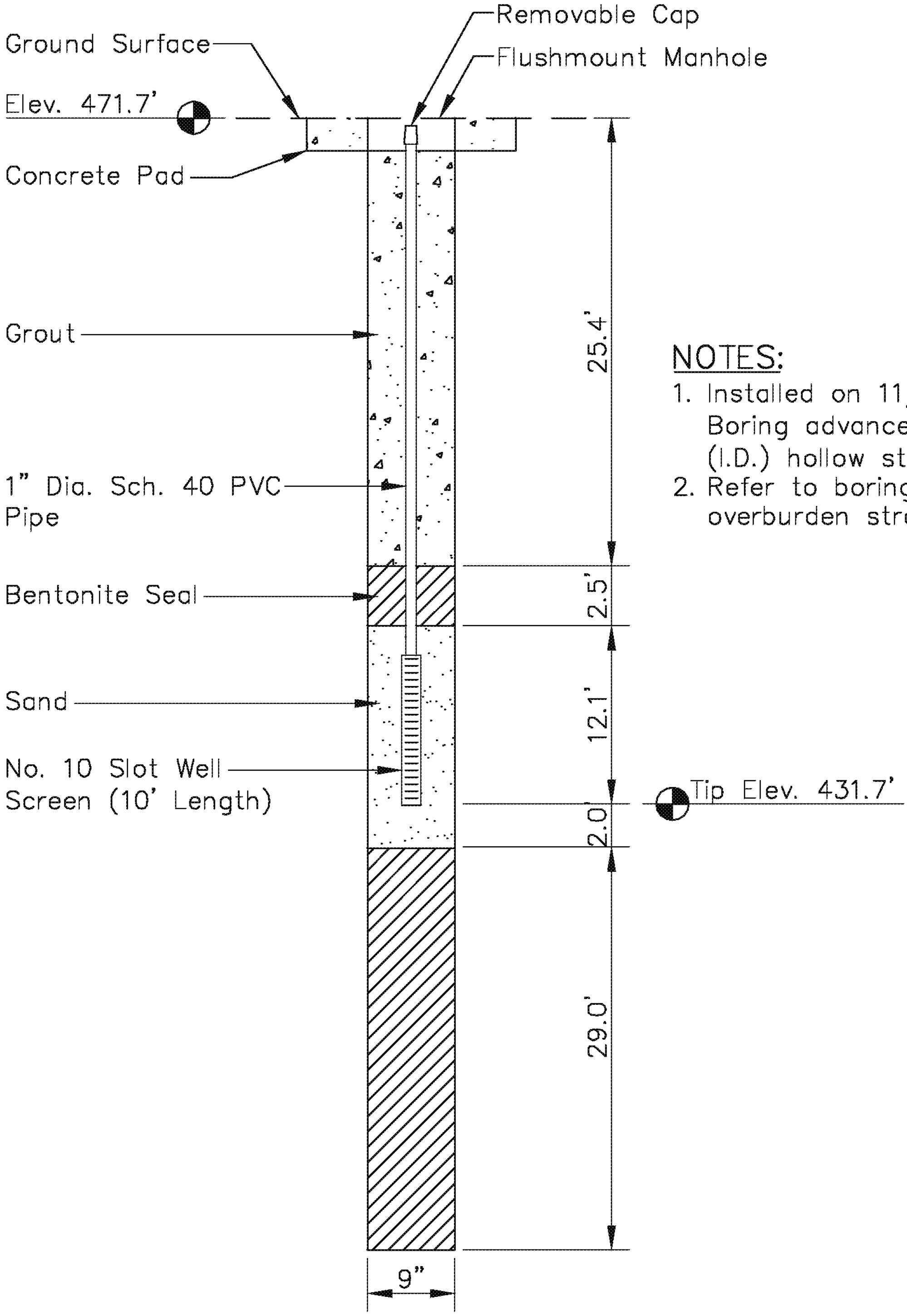
Horizontal Datum: NAD 27
Vertical Datum: NGVD88

PIEZOMETER B-1
WEST BOTTOM ASH DAM
CLIFTY CREEK PLANT

Stantec

Stantec Consulting Services Inc.
11687 Lebanon Rd.
Cincinnati, Ohio
45241-2012
513-842-8200
www.stantec.com

DRAWN BY MJ	DATE FEB., 2010	REVISED			SHEET
CHECKED BY CN	PROJ. NO. 175539022	1.		3.		1 OF 1
CHECKED BY EMK	SCALE NTS	2.		4.		



NOTES:
1. Installed on 11/05/2009. Boring advanced with 4.25" (I.D.) hollow stem augers.
2. Refer to boring log for overburden stratigraphy.

PLOT DATE: 02/18/2010 USER: JENNINGS, MATTHEW
V:\1755\ACTIVE\175539022\GEOTECHNICAL\DRAWING\INSTRUMENTS\PZB3.DWG

LOCATION:
Northing: 448,278.25
Easting: 566,522.86
Ground Elevation: 471.7'

Horizontal Datum: NAD 27
Vertical Datum: NGVD88

PIEZOMETER B-3
WEST BOTTOM ASH DAM
CLIFTY CREEK PLANT

Stantec

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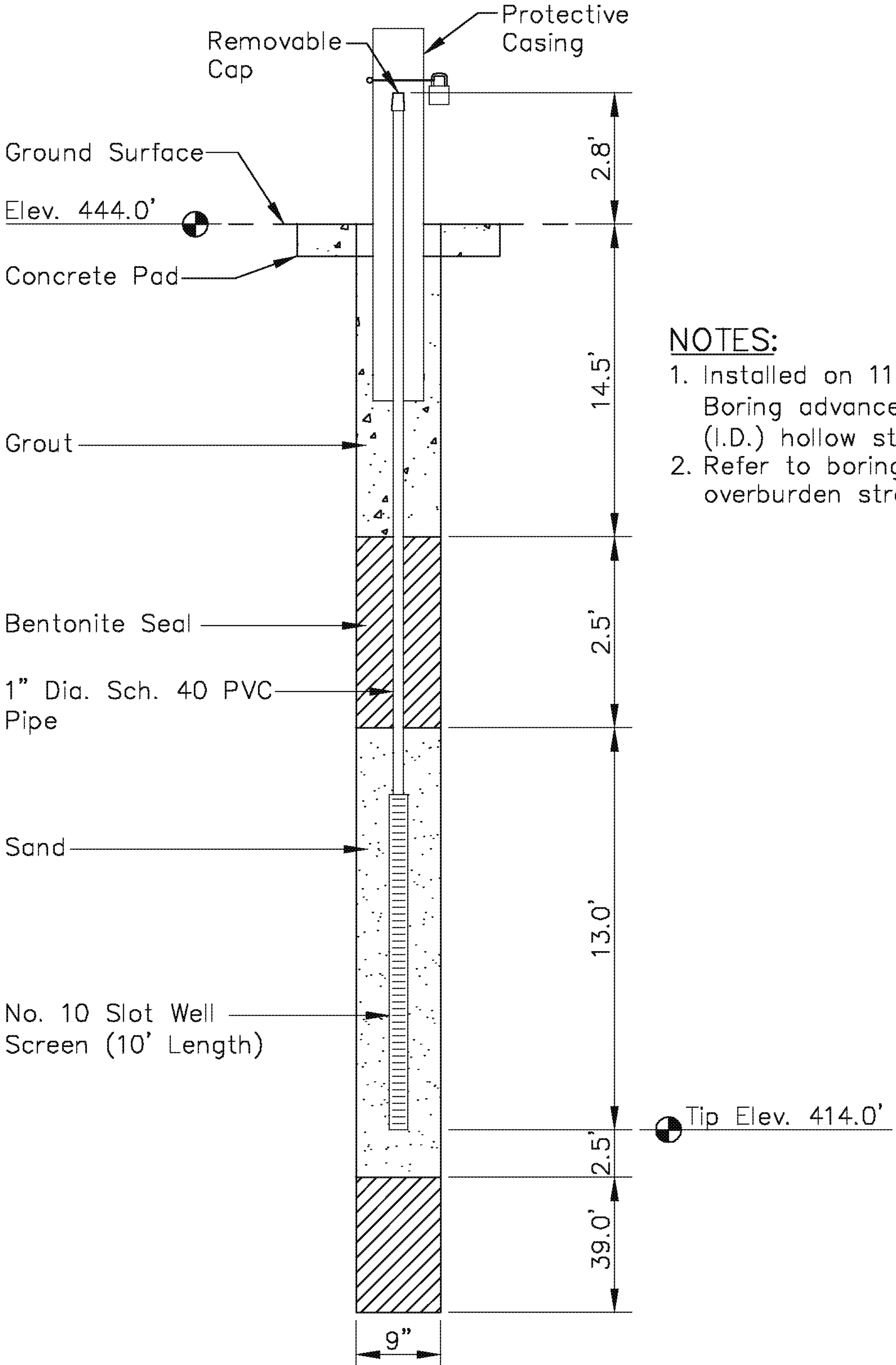
11687 Lebanon Rd.
Cincinnati, Ohio
45241-2012
513-842-8200
www.stantec.com

DRAWN BY	MJ	DATE	FEB., 2010	REVISED		SHEET
CHECKED BY	CN	PROJ. NO.	175539022	1.	3.	1 OF 1
CHECKED BY	EMK	SCALE	NTS	2.	4.	



NOTES:
1. Installed on 11/11/2009. Boring advanced with 4.25" (I.D.) hollow stem augers.
2. Refer to boring log for overburden stratigraphy.

PLOT DATE: 02/18/2010 USER: JENNINGS, MATTHEW
V:\1755\ACTIVE\175539022\GEOTECHNICAL\DRAWING\INSTRUMENTS\PZB4.DWG

LOCATION:
Northing: 448,202.42
Easting: 566,559.67
Ground Elevation: 444.0'

Horizontal Datum: NAD 27
Vertical Datum: NGVD88

PIEZOMETER B-4
WEST BOTTOM ASH DAM
CLIFTY CREEK PLANT

Stantec

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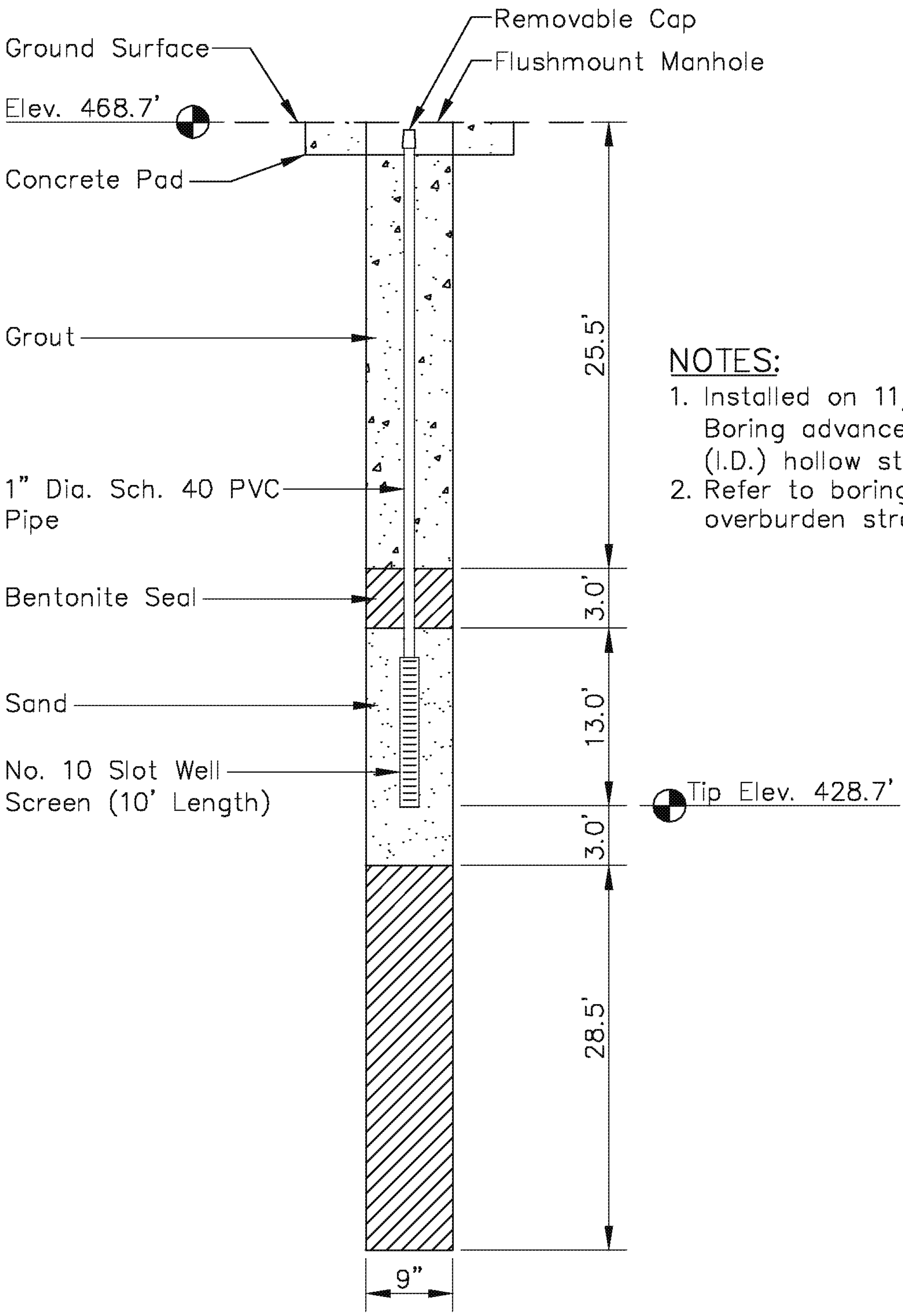
11687 Lebanon Rd.
Cincinnati, Ohio
45241-2012
513-842-8200
www.stantec.com

DRAWN BY CW	DATE FEB., 2010	REVISED			SHEET
CHECKED BY CN	PROJ. NO. 175539022	1.	3.		1 OF 1
CHECKED BY EMK	SCALE NTS	2.	4.		

ED_006570_00010329-00506



NOTES:

1. Installed on 11/10/2009. Boring advanced with 4.25" (I.D.) hollow stem augers.
2. Refer to boring log for overburden stratigraphy.

PLOT DATE: 02/18/2010 USER: JENNINGS, MATTHEW
V:\1755\ACTIVE\175539022\GEOTECHNICAL\DRAWING\INSTRUMENTS\PZB5.DWG

LOCATION:
Northing: 448,958.53
Easting: 567,968.94
Ground Elevation: 468.7'

Horizontal Datum: NAD 27
Vertical Datum: NGVD88

PIEZOMETER B-5
WEST BOTTOM ASH DAM
CLIFTY CREEK PLANT

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Cincinnati, Ohio
45241-2012
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DRAWN BY	MJ	DATE	FEB., 2010	REVISED		SHEET
CHECKED BY	CN	PROJ. NO.	175539022	1.	3.	1 OF 1
CHECKED BY	EMK	SCALE	NTS	2.	4.	

APPENDIX D

SOIL CLASSIFICATION SUMMARIES

BOILER SLAG POND DAM

Stantec

Summary of Soil Tests

Project Name	AEP - Clifty Creek - West Bottom Ash and Fly Ash Ponds	Project Number	175539022
Source	B-1, 10.0'-11.5', 12.5'-14.0'	Lab ID	4
County	Jefferson, IN	Date Received	11-16-09
Sample Type	SPT Comp	Date Reported	11-30-09

Test Results

Natural Moisture Content

Test Method: ASTM D 2216

Moisture Content (%): 19.1

Particle Size Analysis

Preparation Method: ASTM D 421

Gradation Method: ASTM D 422

Hydrometer Method: ASTM D 422

Particle Size		%
Sieve Size	(mm)	Passing
3"	75	
2"	50	
1 1/2"	37.5	
1"	25	
3/4"	19	
3/8"	9.5	
No. 4	4.75	100.0
No. 10	2	99.8
No. 40	0.425	98.4
No. 200	0.075	84.0
	0.02	49.1
	0.005	31.1
	0.002	23.7
estimated	0.001	22.1

Plus 3 in. material, not included: 0 (%)

Range	ASTM (%)	AASHTO (%)
Gravel	0.0	0.2
Coarse Sand	0.2	1.4
Medium Sand	1.4	---
Fine Sand	14.4	14.4
Silt	52.9	60.3
Clay	31.1	23.7

Atterberg Limits

Test Method: ASTM D 4318 Method A

Prepared: Dry

Liquid Limit: 32

Plastic Limit: 19

Plasticity Index: 13

Activity Index: 0.54

Moisture-Density Relationship

Test Not Performed

Maximum Dry Density (lb/ft^3): N/A

Maximum Dry Density (kg/m^3): N/A

Optimum Moisture Content (%): N/A

Over Size Correction %: N/A

California Bearing Ratio

Test Not Performed

Bearing Ratio (%): N/A

Compacted Dry Density (lb/ft^3): N/A

Compacted Moisture Content (%): N/A

Specific Gravity

Test Method: ASTM D 854

Prepared: Dry

Particle Size: No. 10

Specific Gravity at 20° Celsius: 2.70

Classification

Unified Group Symbol: CL

Group Name: Lean clay with sand

AASHTO Classification: A-6 (10)

Comments:

Stantec

Particle-Size Analysis of Soils
ASTM D 422

Project Name: AEP - Clifty Creek - West Bottom Ash and Fly Ash Ponds subsurface Project Number: 175539022
Source: B-1, 10.0'-11.5', 12.5'-14.0' Lab ID: 4

Sieve analysis for the Portion Coarser than the No. 10 Sieve

Test Method: ASTM D 422
Prepared using: ASTM D 421

Particle Shape: Angular
Particle Hardness: Hard and Durable

Tested By: KR
Test Date: 11-20-2009
Date Received 11-16-2009

Maximum Particle size: No. 4 Sieve

Sieve Size	% Passing
3"	
2"	
1 1/2"	
1"	
3/4"	
3/8"	
No. 4	100.0
No. 10	99.8

Analysis for the portion Finer than the No. 10 Sieve

Analysis Based on: Total Sample

Specific Gravity 2.7

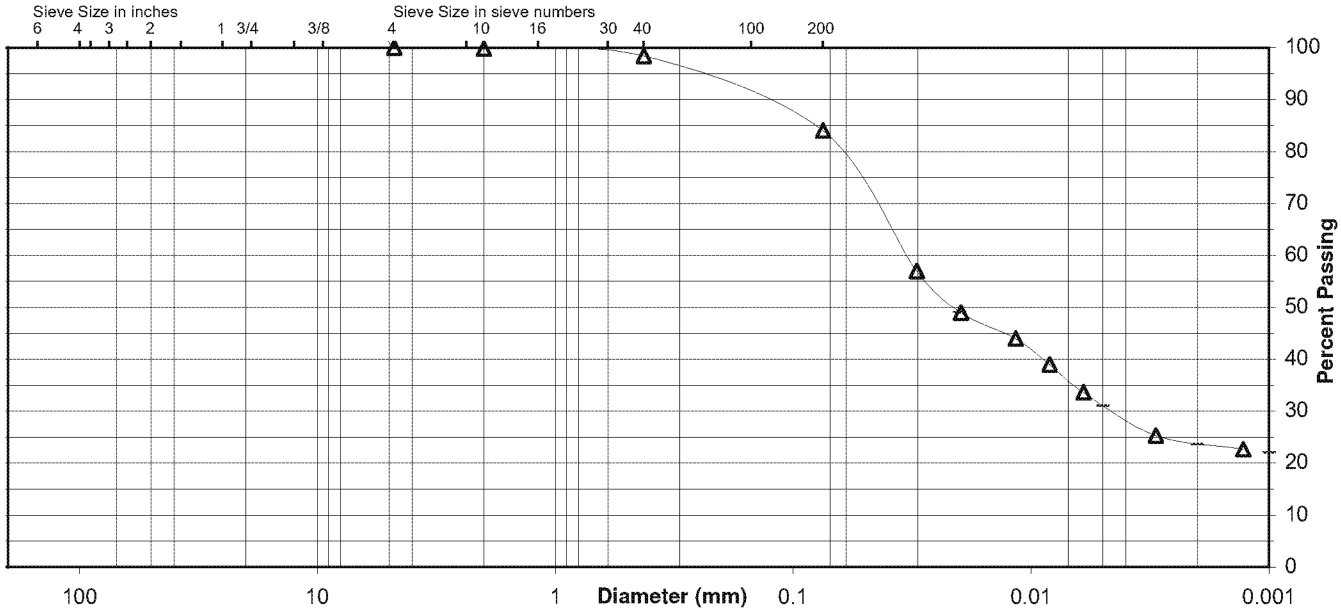
Dispersed using: Apparatus A - Mechanical, for 1 minute

No. 40	98.4
No. 200	84.0
0.02 mm	49.1
0.005 mm	31.1
0.002 mm	23.7
0.001 mm	22.1

Particle Size Distribution

ASTM	Coarse Gravel	Fine Gravel	C. Sand	Medium Sand	Fine Sand	Silt	Clay
	0.0	0.0	0.2	1.4	14.4	52.9	31.1

AASHTO	Gravel	Coarse Sand	Fine Sand	Silt	Clay
	0.2	1.4	14.4	60.3	23.7



Comments

Reviewed By

File: frm_175539022_sum_4 Sheet: Hydro-Report
Preparation Date: 1998
Revision Date: 1-2008

Stantec Consulting Services Inc.

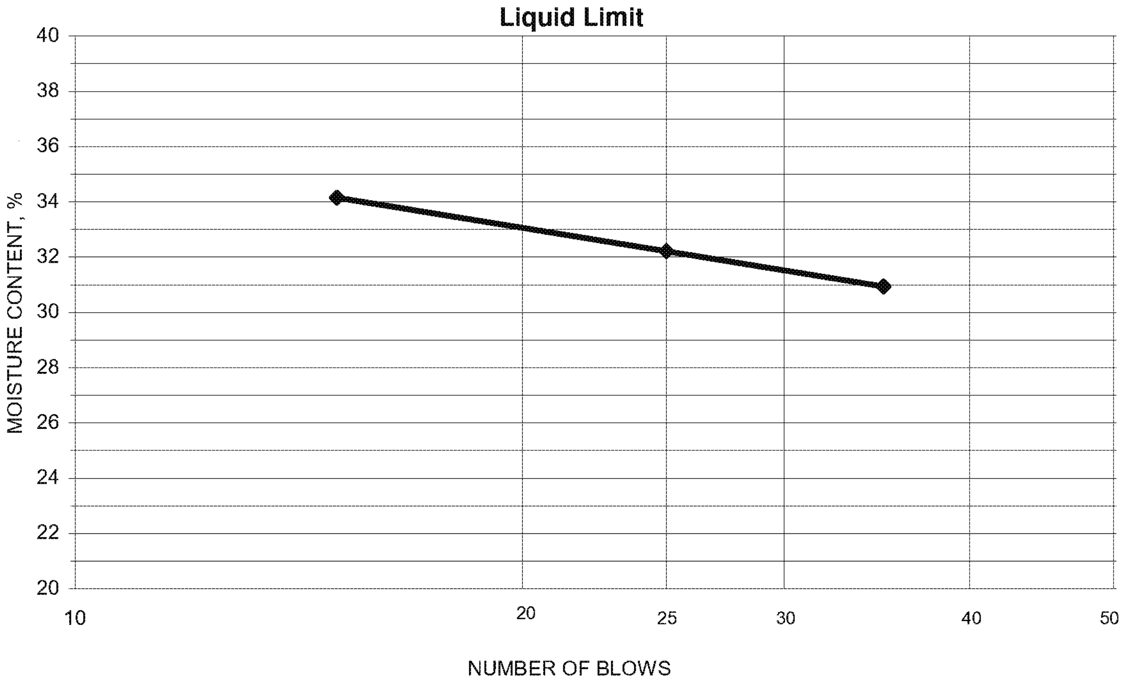
Laboratory Document
Prepared By: MW
Approved BY: TLK

Stantec

ATTERBERG LIMITS

Project	AEP - Clifty Creek - West Bottom Ash and Fly Ash Ponds subsurface e:	Project No.	175539022
Source	B-1, 10.0'-11.5', 12.5'-14.0'	Lab ID	4
		% + No. 40	2
Tested By	RG	Test Method	ASTM D 4318 Method A
Date Received	11-16-2009		
Test Date	11-23-2009	Prepared	Dry

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Number of Blows	Water Content (%)	Liquid Limit
22.20	19.41	11.24	15	34.1	32
20.53	18.13	10.68	25	32.2	
22.58	19.87	11.11	35	30.9	



PLASTIC LIMIT AND PLASTICITY INDEX

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Water Content (%)	Plastic Limit	Plasticity Index
24.73	22.56	11.06	18.9	19	13
24.53	22.36	11.08	19.2		

Remarks: ______________________

Reviewed By ______________

Stantec

Summary of Soil Tests

Project Name	AEP - Clifty Creek - West Bottom Ash and Fly Ash Ponds	Project Number	175539022
Source	B-1, 47.5'-49.0', 50.0'-51.5'	Lab ID	20
County	Jefferson, IN	Date Received	11-16-09
Sample Type	SPT Comp	Date Reported	11-30-09

Test Results

Natural Moisture Content

Test Method: ASTM D 2216

Moisture Content (%): 25.3

Particle Size Analysis

Preparation Method: ASTM D 421

Gradation Method: ASTM D 422

Hydrometer Method: ASTM D 422

Particle Size		%
Sieve Size	(mm)	Passing
3"	75	
2"	50	
1 1/2"	37.5	
1"	25	
3/4"	19	
3/8"	9.5	100.0
No. 4	4.75	100.0
No. 10	2	99.9
No. 40	0.425	99.7
No. 200	0.075	84.1
	0.02	54.5
	0.005	28.2
	0.002	20.4
estimated	0.001	17.1

Plus 3 in. material, not included: 0 (%)

Range	ASTM (%)	AASHTO (%)
Gravel	0.0	0.1
Coarse Sand	0.1	0.2
Medium Sand	0.2	---
Fine Sand	15.6	15.6
Silt	55.9	63.7
Clay	28.2	20.4

Atterberg Limits

Test Method: ASTM D 4318 Method A

Prepared: Dry

Liquid Limit: 28

Plastic Limit: 16

Plasticity Index: 12

Activity Index: 0.60

Moisture-Density Relationship

Test Not Performed

Maximum Dry Density (lb/ft^3): N/A

Maximum Dry Density (kg/m^3): N/A

Optimum Moisture Content (%): N/A

Over Size Correction %: N/A

California Bearing Ratio

Test Not Performed

Bearing Ratio (%): N/A

Compacted Dry Density (lb/ft^3): N/A

Compacted Moisture Content (%): N/A

Specific Gravity

Test Method: ASTM D 854

Prepared: Dry

Particle Size: No. 10

Specific Gravity at 20° Celsius: 2.77

Classification

Unified Group Symbol: CL

Group Name: Lean clay with sand

AASHTO Classification: A-6 (8)

Comments:

Stantec

Particle-Size Analysis of Soils
ASTM D 422

Project Name: AEP - Clifty Creek - West Bottom Ash and Fly Ash Ponds subsurface exp | Project Number: 175539022
Source: B-1, 47.5'-49.0', 50.0'-51.5' | Lab ID: 20

Sieve analysis for the Portion Coarser than the No. 10 Sieve

Test Method: ASTM D 422
Prepared using: ASTM D 421

Particle Shape: Angular
Particle Hardness: Hard and Durable

Tested By: KR
Test Date: 11-20-2009
Date Received: 11-16-2009

Maximum Particle size: 3/8" Sieve

Sieve Size	% Passing
3"	
2"	
1 1/2"	
1"	
3/4"	
3/8"	100.0
No. 4	100.0
No. 10	99.9

Analysis for the portion Finer than the No. 10 Sieve

Analysis Based on: Total Sample

Specific Gravity: 2.77

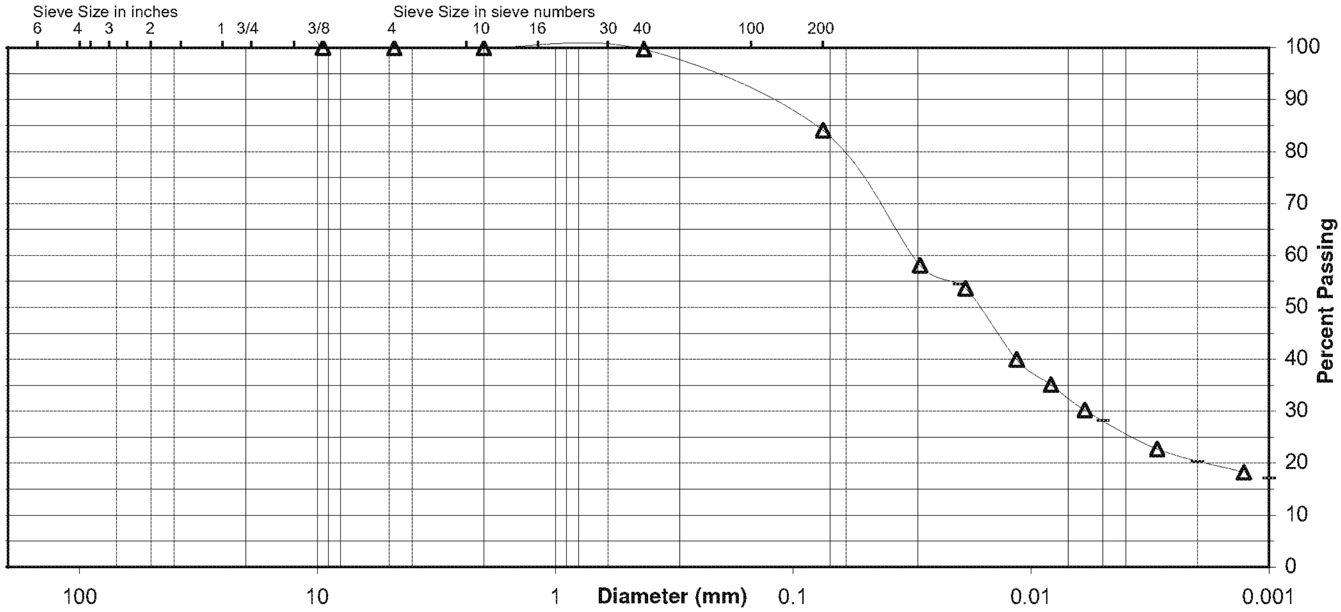
Dispersed using: Apparatus A - Mechanical, for 1 minute

No. 40	99.7
No. 200	84.1
0.02 mm	54.5
0.005 mm	28.2
0.002 mm	20.4
0.001 mm	17.1

Particle Size Distribution

ASTM	Coarse Gravel	Fine Gravel	C. Sand	Medium Sand	Fine Sand	Silt	Clay
	0.0	0.0	0.1	0.2	15.6	55.9	28.2

AASHTO	Gravel	Coarse Sand	Fine Sand	Silt	Clay
	0.1	0.2	15.6	63.7	20.4



Comments

Reviewed By

File: frm_175539022_sum_20 Sheet: Hydro-Report
Preparation Date: 1998
Revision Date: 1-2008

Stantec Consulting Services Inc.

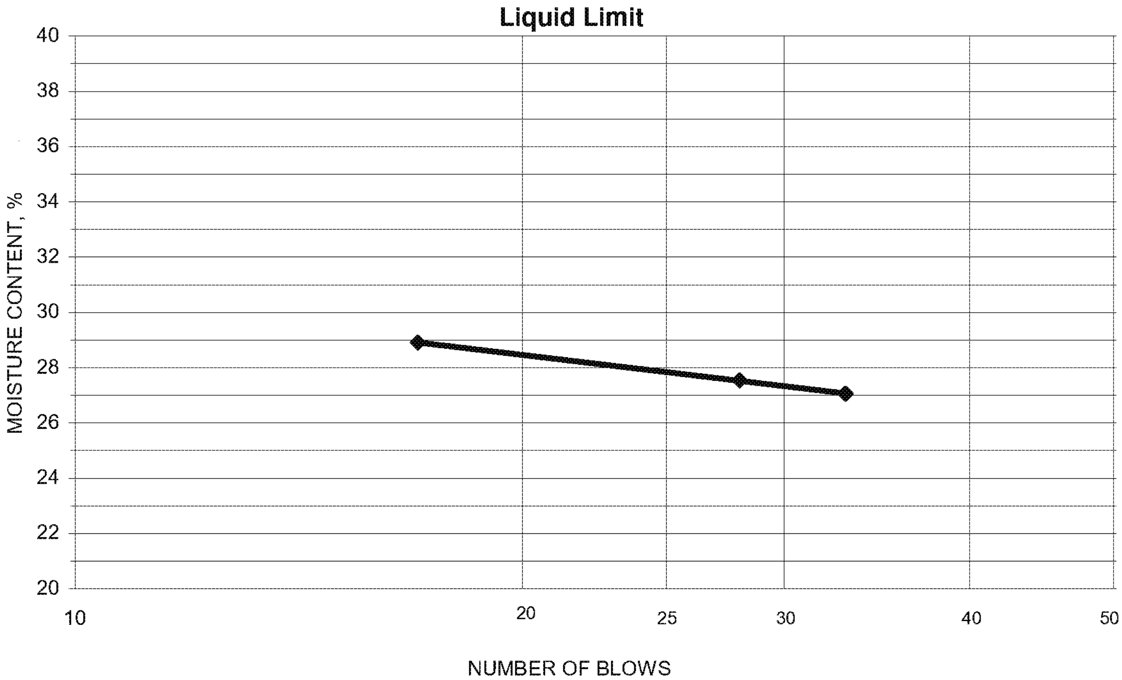
Laboratory Document
Prepared By: MW
Approved BY: TLK

Stantec

ATTERBERG LIMITS

Project	AEP - Clifty Creek - West Bottom Ash and Fly Ash Ponds subsurface e:	Project No.	175539022
Source	B-1, 47.5'-49.0', 50.0'-51.5'	Lab ID	20
		% + No. 40	0
Tested By	RG	Test Method	ASTM D 4318 Method A
Date Received	11-16-2009		
Test Date	11-23-2009	Prepared	Dry

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Number of Blows	Water Content (%)	Liquid Limit
23.68	21.01	11.14	33	27.1	28
23.20	20.50	11.16	17	28.9	
23.78	21.05	11.14	28	27.5	



PLASTIC LIMIT AND PLASTICITY INDEX

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Water Content (%)	Plastic Limit	Plasticity Index
25.05	23.09	10.96	16.2	16	12
22.52	20.86	10.61	16.2		

Remarks:

Reviewed By

Stantec

Summary of Soil Tests

Project Name	AEP - Clifty Creek - West Bottom Ash and Fly Ash Ponds	Project Number	175539022
Source	B-2, 32.5'-34.0', 35.0'-36.5'	Lab ID	43
County	Jefferson, IN	Date Received	11-16-09
Sample Type	SPT Comp	Date Reported	11-30-09

Test Results

Natural Moisture Content
Test Method: ASTM D 2216
Moisture Content (%): 32.1

Particle Size Analysis
Preparation Method: ASTM D 421
Gradation Method: ASTM D 422
Hydrometer Method: ASTM D 422

Particle Size Sieve Size	Particle Size (mm)	% Passing
3"	75	
2"	50	
1 1/2"	37.5	
1"	25	
3/4"	19	
3/8"	9.5	100.0
No. 4	4.75	99.7
No. 10	2	99.7
No. 40	0.425	98.7
No. 200	0.075	79.7
	0.02	50.6
	0.005	28.1
	0.002	19.7
estimated	0.001	16.0

Plus 3 in. material, not included: 0 (%)

Range	ASTM (%)	AASHTO (%)
Gravel	0.3	0.3
Coarse Sand	0.0	1.0
Medium Sand	1.0	---
Fine Sand	19.0	19.0
Silt	51.6	60.0
Clay	28.1	19.7

Atterberg Limits
Test Method: ASTM D 4318 Method A
Prepared: Dry
Liquid Limit: 33
Plastic Limit: 15
Plasticity Index: 18
Activity Index: 0.90

Moisture-Density Relationship
Test Not Performed
Maximum Dry Density (lb/ft^3): N/A
Maximum Dry Density (kg/m^3): N/A
Optimum Moisture Content (%): N/A
Over Size Correction %: N/A

California Bearing Ratio
Test Not Performed
Bearing Ratio (%): N/A
Compacted Dry Density (lb/ft^3): N/A
Compacted Moisture Content (%): N/A

Specific Gravity
Test Method: ASTM D 854
Prepared: Dry
Particle Size: No. 10
Specific Gravity at 20° Celsius: 2.72

Classification
Unified Group Symbol: CL
Group Name: Lean clay with sand
AASHTO Classification: A-6 (13)

Comments:

Stantec

Particle-Size Analysis of Soils
ASTM D 422

Project Name AEP - Clifty Creek - West Bottom Ash and Fly Ash Ponds subsurface exProject Number 175539022
Source B-2, 32.5'-34.0', 35.0'-36.5' Lab ID 43

Sieve analysis for the Portion Coarser than the No. 10 Sieve

Test Method: ASTM D 422
Prepared using: ASTM D 421

Particle Shape: Angular
Particle Hardness: Hard and Durable

Tested By: KR
Test Date: 11-20-2009
Date Received 11-16-2009

Maximum Particle size: 3/8" Sieve

Sieve Size	% Passing
3"	
2"	
1 1/2"	
1"	
3/4"	
3/8"	100.0
No. 4	99.7
No. 10	99.7

Analysis for the portion Finer than the No. 10 Sieve

Analysis Based on: Total Sample

Specific Gravity 2.72

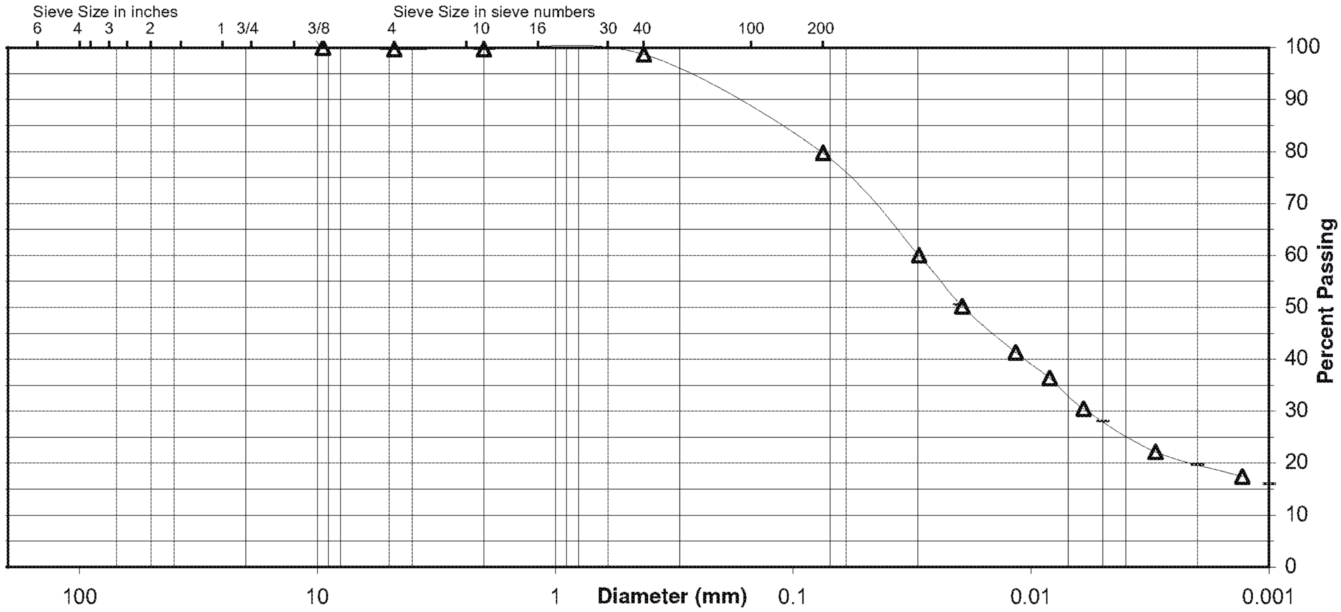
Dispersed using: Apparatus A - Mechanical, for 1 minute

No. 40	98.7
No. 200	79.7
0.02 mm	50.6
0.005 mm	28.1
0.002 mm	19.7
0.001 mm	16.0

Particle Size Distribution

ASTM	Coarse Gravel	Fine Gravel	C. Sand	Medium Sand	Fine Sand	Silt	Clay
	0.0	0.3	0.0	1.0	19.0	51.6	28.1

AASHTO	Gravel	Coarse Sand	Fine Sand	Silt	Clay
	0.3	1.0	19.0	60.0	19.7



Comments

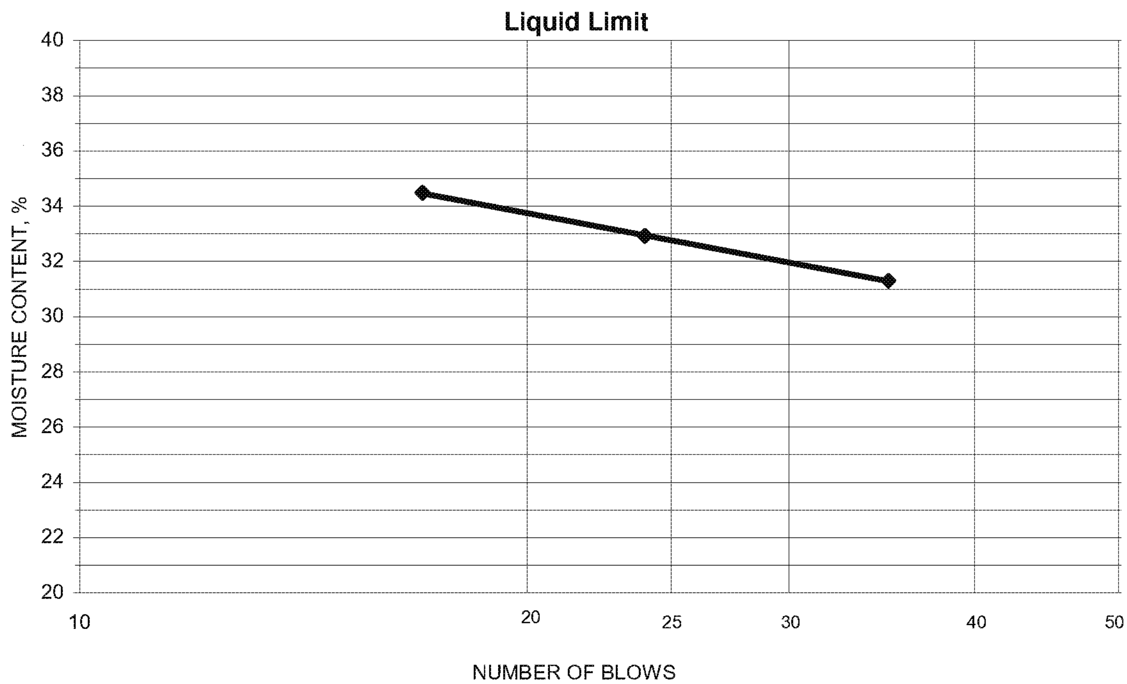
Reviewed By

Stantec

ATTERBERG LIMITS

Project	AEP - Clifty Creek - West Bottom Ash and Fly Ash Ponds subsurface e:	Project No.	175539022
Source	B-2, 32.5'-34.0', 35.0'-36.5'	Lab ID	43
		% + No. 40	1
Tested By	KR	Test Method	ASTM D 4318 Method A
Date Received	11-16-2009		
Test Date	11-23-2009	Prepared	Dry

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Number of Blows	Water Content (%)	Liquid Limit
23.26	20.15	11.13	17	34.5	
23.44	20.29	10.72	24	32.9	
24.86	21.58	11.10	35	31.3	33



PLASTIC LIMIT AND PLASTICITY INDEX

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Water Content (%)	Plastic Limit	Plasticity Index
21.11	19.78	10.98	15.1	15	18
21.07	19.72	10.97	15.4		

Remarks: ______________________

Reviewed By ______________

Stantec

Summary of Soil Tests

Project Name	AEP - Clifty Creek - West Bottom Ash and Fly Ash Ponds	Project Number	175539022
Source	B-4, 20.0'-21.5', 22.5'-24.0'	Lab ID	87
County	Jefferson, IN	Date Received	11-16-09
Sample Type	SPT Comp	Date Reported	11-30-09

Test Results

Natural Moisture Content

Test Method: ASTM D 2216

Moisture Content (%): 26.6

Particle Size Analysis

Preparation Method: ASTM D 421

Gradation Method: ASTM D 422

Hydrometer Method: ASTM D 422

Particle Size		%
Sieve Size	(mm)	Passing
3"	75	
2"	50	
1 1/2"	37.5	
1"	25	
3/4"	19	
3/8"	9.5	
No. 4	4.75	100.0
No. 10	2	100.0
No. 40	0.425	99.7
No. 200	0.075	80.7
	0.02	52.0
	0.005	27.7
	0.002	19.5
estimated	0.001	15.1

Plus 3 in. material, not included: 0 (%)

	ASTM	AASHTO
Range	(%)	(%)
Gravel	0.0	0.0
Coarse Sand	0.0	0.3
Medium Sand	0.3	---
Fine Sand	19.0	19.0
Silt	53.0	61.2
Clay	27.7	19.5

Atterberg Limits

Test Method: ASTM D 4318 Method A

Prepared: Dry

Liquid Limit: 25

Plastic Limit: 17

Plasticity Index: 8

Activity Index: 0.40

Moisture-Density Relationship

Test Not Performed

Maximum Dry Density (lb/ft^3): N/A

Maximum Dry Density (kg/m^3): N/A

Optimum Moisture Content (%): N/A

Over Size Correction %: N/A

California Bearing Ratio

Test Not Performed

Bearing Ratio (%): N/A

Compacted Dry Density (lb/ft^3): N/A

Compacted Moisture Content (%): N/A

Specific Gravity

Test Method: ASTM D 854

Prepared: Dry

Particle Size: No. 10

Specific Gravity at 20° Celsius: 2.60

Classification

Unified Group Symbol: CL

Group Name: Lean clay with sand

AASHTO Classification: A-4 (4)

Comments:

Stantec

Particle-Size Analysis of Soils
ASTM D 422

Project Name	AEP - Clifty Creek - West Bottom Ash and Fly Ash Ponds subsurface project	Project Number	175539022
Source	B-4, 20.0'-21.5', 22.5'-24.0'	Lab ID	87

Sieve analysis for the Portion Coarser than the No. 10 Sieve

Test Method: ASTM D 422
Prepared using: ASTM D 421

Particle Shape: Angular
Particle Hardness: Hard and Durable

Tested By: KR
Test Date: 11-20-2009
Date Received 11-16-2009

Maximum Particle size: No. 4 Sieve

Sieve Size	% Passing
3"	
2"	
1 1/2"	
1"	
3/4"	
3/8"	
No. 4	100.0
No. 10	100.0

Analysis for the portion Finer than the No. 10 Sieve

Analysis Based on: Total Sample

Specific Gravity 2.6

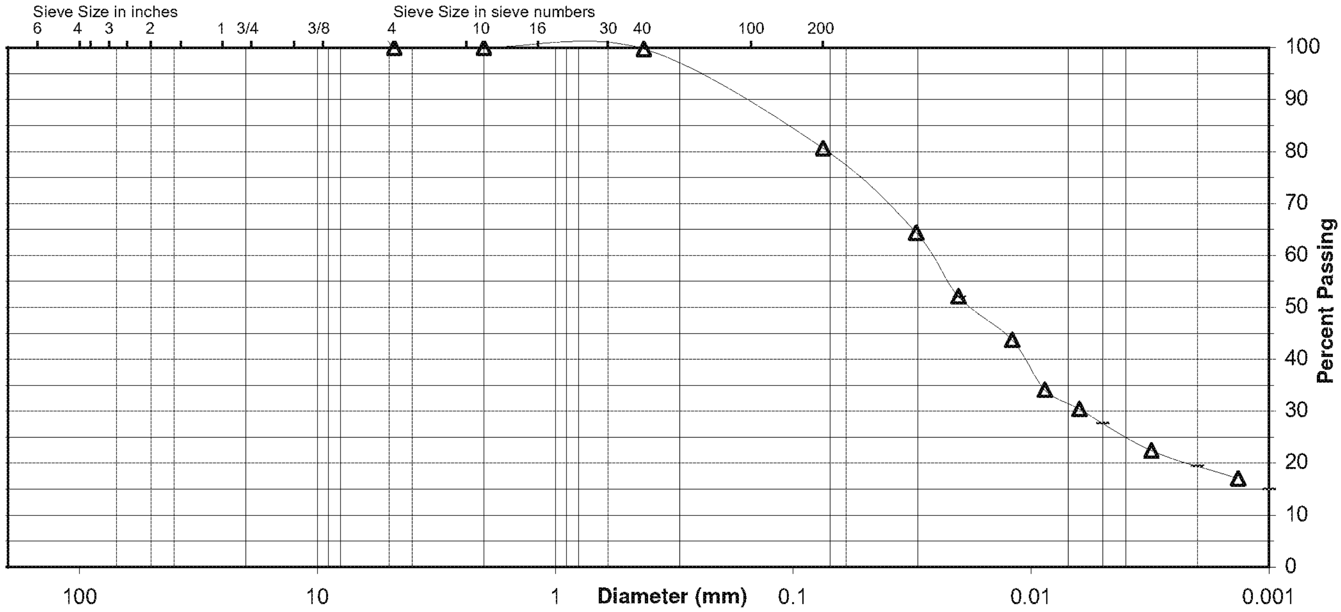
Dispersed using: Apparatus A - Mechanical, for 1 minute

No. 40	99.7
No. 200	80.7
0.02 mm	52.0
0.005 mm	27.7
0.002 mm	19.5
0.001 mm	15.1

Particle Size Distribution

ASTM	Coarse Gravel	Fine Gravel	C. Sand	Medium Sand	Fine Sand	Silt	Clay
	0.0	0.0	0.0	0.3	19.0	53.0	27.7

AASHTO	Gravel	Coarse Sand	Fine Sand	Silt	Clay
	0.0	0.3	19.0	61.2	19.5



Comments

Reviewed By

File: frm_175539022_sum_87 Sheet: Hydro-Report
Preparation Date: 1998
Revision Date: 1-2008

Stantec Consulting Services Inc.

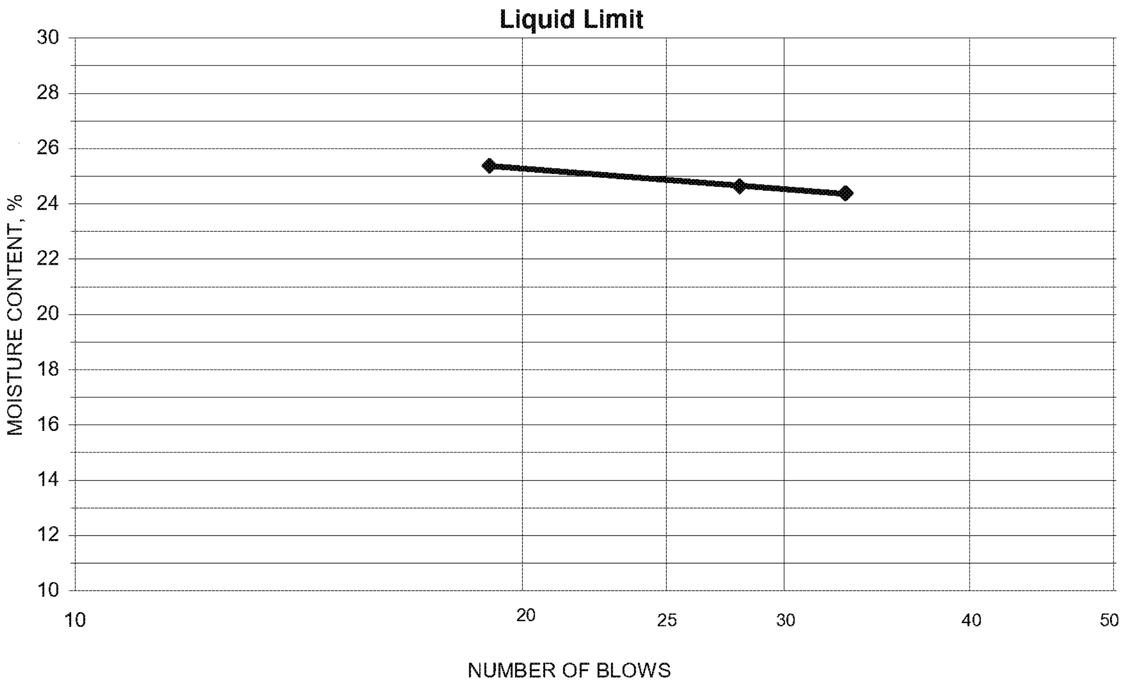
Laboratory Document
Prepared By: MW
Approved BY: TLK

Stantec

ATTERBERG LIMITS

Project	AEP - Clifty Creek - West Bottom Ash and Fly Ash Ponds subsurface e:	Project No.	175539022
Source	B-4, 20.0'-21.5', 22.5'-24.0'	Lab ID	87
		% + No. 40	0
Tested By	RG	Test Method	ASTM D 4318 Method A
Date Received	11-16-2009		
Test Date	11-23-2009	Prepared	Dry

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Number of Blows	Water Content (%)	Liquid Limit
24.04	21.40	10.57	33	24.4	
23.55	21.04	11.15	19	25.4	
23.10	20.72	11.06	28	24.6	25



PLASTIC LIMIT AND PLASTICITY INDEX

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Water Content (%)	Plastic Limit	Plasticity Index
24.08	22.17	11.08	17.2	17	8
25.29	23.10	10.68	17.6		

Remarks: ______________________

Reviewed By ______________

Stantec

Summary of Soil Tests

Project Name	AEP - Clifty Creek - West Bottom Ash and Fly Ash Ponds	Project Number	175539022
Source	B-4, 57.5'-59.0', 60.0'-61.5'	Lab ID	103
County	Jefferson, IN	Date Received	11-16-09
Sample Type	SPT Comp	Date Reported	11-30-09

Test Results

Natural Moisture Content
Test Method: ASTM D 2216
Moisture Content (%): 10.9

Particle Size Analysis
Preparation Method: ASTM D 421
Gradation Method: ASTM D 422
Hydrometer Method: ASTM D 422

Particle Size		%
Sieve Size	(mm)	Passing
3"	75	
2"	50	
1 1/2"	37.5	100.0
1"	25	97.1
3/4"	19	92.5
3/8"	9.5	72.7
No. 4	4.75	46.1
No. 10	2	32.6
No. 40	0.425	13.6
No. 200	0.075	5.7
	0.02	2.9
	0.005	1.5
	0.002	1.1
estimated	0.001	0.9

Plus 3 in. material, not included: 0 (%)

Range	ASTM (%)	AASHTO (%)
Gravel	53.9	67.4
Coarse Sand	13.5	19.0
Medium Sand	19.0	---
Fine Sand	7.9	7.9
Silt	4.2	4.6
Clay	1.5	1.1

Atterberg Limits
Test Method: ASTM D 4318 Method A
Prepared: Dry
Liquid Limit: ---
Plastic Limit: Non Plastic
Plasticity Index: ---
Activity Index: N/A

Moisture-Density Relationship
Test Not Performed
Maximum Dry Density (lb/ft^3): N/A
Maximum Dry Density (kg/m^3): N/A
Optimum Moisture Content (%): N/A
Over Size Correction %: N/A

California Bearing Ratio
Test Not Performed
Bearing Ratio (%): N/A
Compacted Dry Density (lb/ft^3): N/A
Compacted Moisture Content (%): N/A

Specific Gravity
Test Method: ASTM D 854
Prepared: Dry
Particle Size: No. 10
Specific Gravity at 20° Celsius: 2.72

Classification
Unified Group Symbol: GW-GM
Group Name: Well-graded gravel with silt and sand
AASHTO Classification: A-1-a (1)

Comments:

Stantec

Particle-Size Analysis of Soils
ASTM D 422

Project Name: AEP - Clifty Creek - West Bottom Ash and Fly Ash Ponds subsurface Project Number: 175539022
Source: B-4, 57.5'-59.0', 60.0'-61.5' Lab ID: 103

Sieve analysis for the Portion Coarser than the No. 10 Sieve

Test Method: ASTM D 422
Prepared using: ASTM D 421

Particle Shape: Angular
Particle Hardness: Hard and Durable

Tested By: KR
Test Date: 11-20-2009
Date Received 11-16-2009

Maximum Particle size: 1 1/2" Sieve

Sieve Size	% Passing
3"	
2"	
1 1/2"	100.0
1"	97.1
3/4"	92.5
3/8"	72.7
No. 4	46.1
No. 10	32.6

Analysis for the portion Finer than the No. 10 Sieve

Analysis Based on: Total Sample

Specific Gravity 2.72

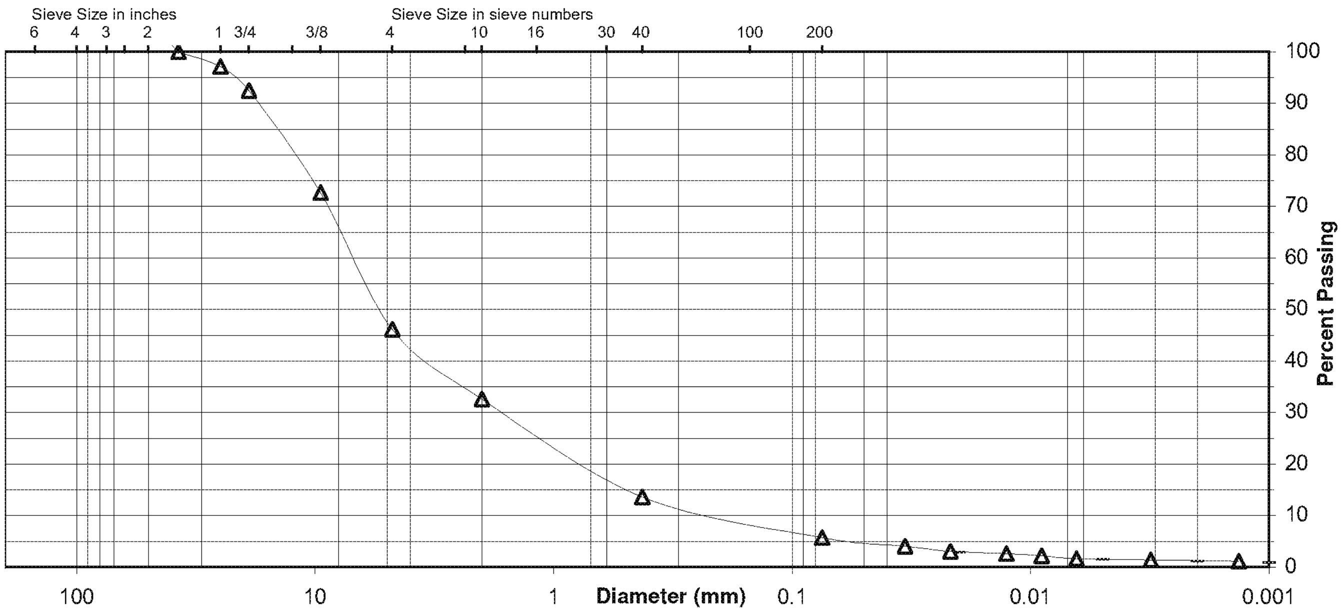
Dispersed using: Apparatus A - Mechanical, for 1 minute

No. 40	13.6
No. 200	5.7
0.02 mm	2.9
0.005 mm	1.5
0.002 mm	1.1
0.001 mm	0.9

Particle Size Distribution

ASTM	Coarse Gravel	Fine Gravel	C. Sand	Medium Sand	Fine Sand	Silt	Clay
	7.5	46.4	13.5	19.0	7.9	4.2	1.5

AASHTO	Gravel	Coarse Sand	Fine Sand	Silt	Clay
	67.4	19.0	7.9	4.6	1.1



Comments

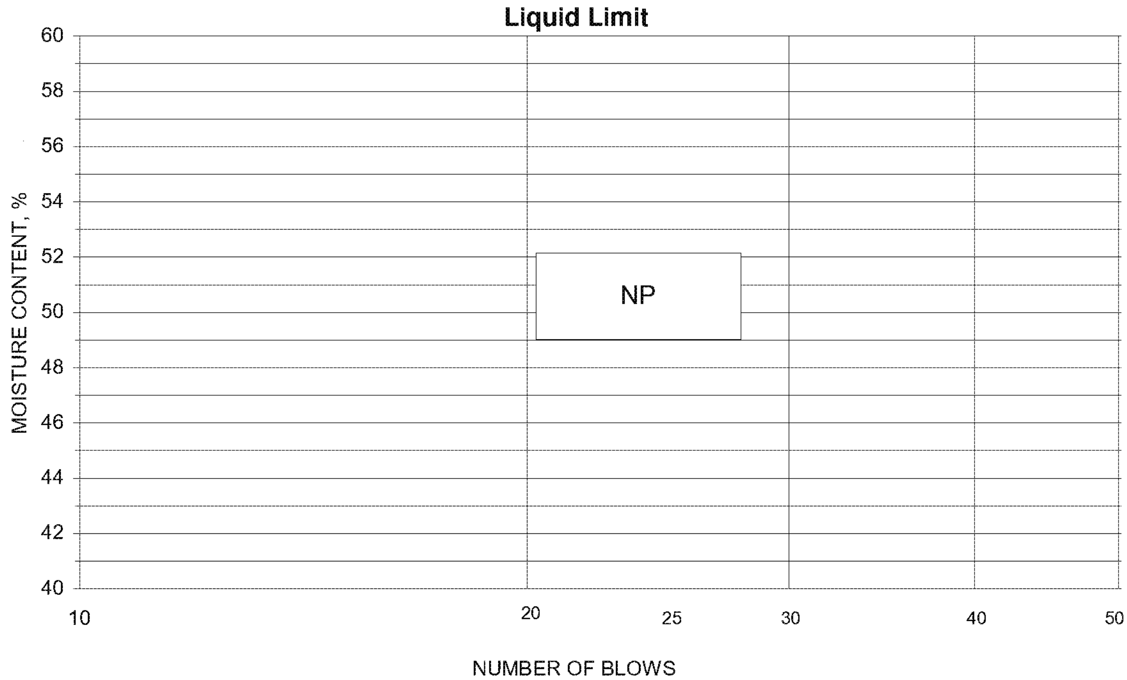
Reviewed By

Stantec

ATTERBERG LIMITS

Project	AEP - Clifty Creek - West Bottom Ash and Fly Ash Ponds subsurface e:	Project No.	175539022
Source	B-4, 57.5'-59.0', 60.0'-61.5'	Lab ID	103
		% + No. 40	86
Tested By	RG	Test Method	ASTM D 4318 Method A
Date Received	11-16-2009		
Test Date	11-23-2009	Prepared	Dry

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Number of Blows	Water Content (%)	Liquid Limit
					#VALUE!



PLASTIC LIMIT AND PLASTICITY INDEX

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Water Content (%)	Plastic Limit	Plasticity Index
					#VALUE!

Remarks: ______

Reviewed By ______

Stantec

Summary of Soil Tests

Project Name	AEP - Clifty Creek - West Bottom Ash and Fly Ash Ponds	Project Number	175539022
Source	B-5, 55.0'-56.5', 57.5'-59.0'	Lab ID	129
County	Jefferson, IN	Date Received	11-16-09
Sample Type	SPT Comp	Date Reported	11-30-09

Test Results

Natural Moisture Content

Test Method: ASTM D 2216

Moisture Content (%): 24.9

Particle Size Analysis

Preparation Method: ASTM D 421
Gradation Method: ASTM D 422
Hydrometer Method: ASTM D 422

Particle Size Sieve Size	(mm)	% Passing
3"	75	
2"	50	
1 1/2"	37.5	
1"	25	
3/4"	19	
3/8"	9.5	100.0
No. 4	4.75	100.0
No. 10	2	100.0
No. 40	0.425	99.9
No. 200	0.075	54.0
	0.02	26.2
	0.005	16.7
	0.002	13.0
estimated	0.001	10.5

Plus 3 in. material, not included: 0 (%)

Range	ASTM (%)	AASHTO (%)
Gravel	0.0	0.0
Coarse Sand	0.0	0.1
Medium Sand	0.1	---
Fine Sand	45.9	45.9
Silt	37.3	41.0
Clay	16.7	13.0

Atterberg Limits

Test Method: ASTM D 4318 Method A
Prepared: Dry

Liquid Limit: ---
Plastic Limit: Non Plastic
Plasticity Index: ---
Activity Index: N/A

Moisture-Density Relationship

Test Not Performed

Maximum Dry Density (lb/ft^3): N/A
Maximum Dry Density (kg/m^3): N/A
Optimum Moisture Content (%): N/A
Over Size Correction %: N/A

California Bearing Ratio

Test Not Performed

Bearing Ratio (%): N/A
Compacted Dry Density (lb/ft^3): N/A
Compacted Moisture Content (%): N/A

Specific Gravity

Test Method: ASTM D 854
Prepared: Dry

Particle Size: No. 10
Specific Gravity at 20° Celsius: 2.74

Classification

Unified Group Symbol: ML
Group Name: Sandy silt

AASHTO Classification: A-4 (0)

Comments:

Particle-Size Analysis of Soils
ASTM D 422

Project Name	AEP - Clifty Creek - West Bottom Ash and Fly Ash Ponds subsurface	Project Number	175539022
Source	B-5, 55.0'-56.5', 57.5'-59.0'	Lab ID	129

Sieve analysis for the Portion Coarser than the No. 10 Sieve

Test Method: ASTM D 422
Prepared using: ASTM D 421

Particle Shape: Angular
Particle Hardness: Hard and Durable

Tested By: KR
Test Date: 11-20-2009
Date Received 11-16-2009

Maximum Particle size: 3/8" Sieve

Sieve Size	% Passing
3"	
2"	
1 1/2"	
1"	
3/4"	
3/8"	100.0
No. 4	100.0
No. 10	100.0

Analysis for the portion Finer than the No. 10 Sieve

Analysis Based on: Total Sample

Specific Gravity 2.74

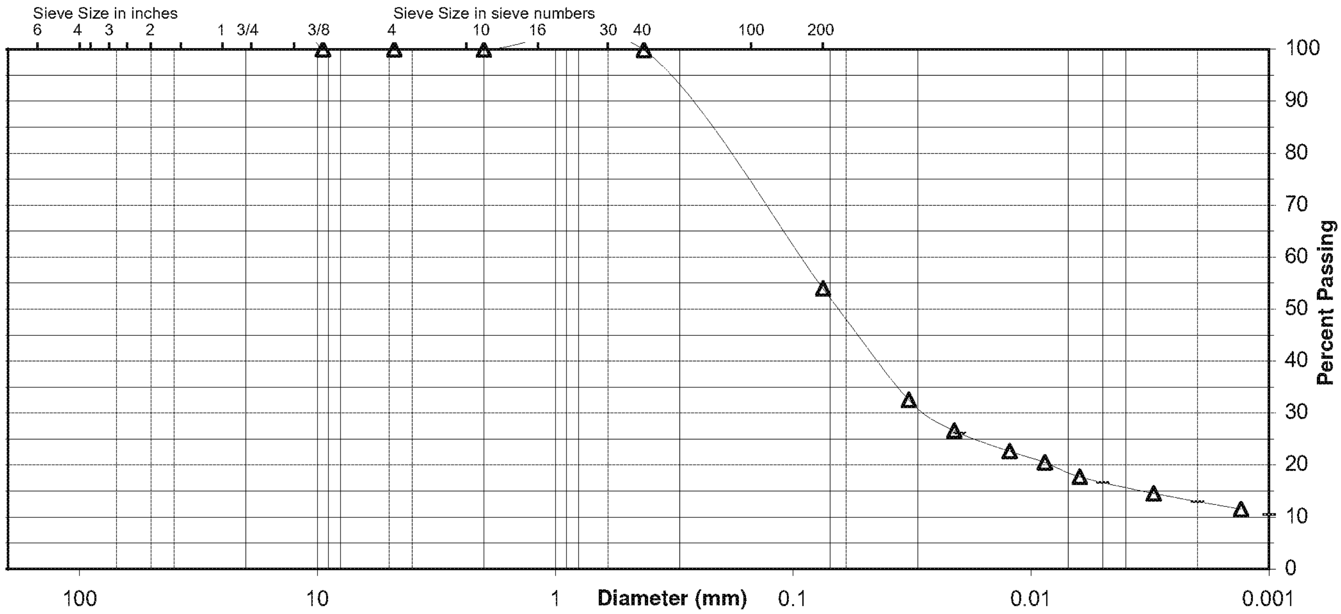
Dispersed using: Apparatus A - Mechanical, for 1 minute

No. 40	99.9
No. 200	54.0
0.02 mm	26.2
0.005 mm	16.7
0.002 mm	13.0
0.001 mm	10.5

Particle Size Distribution

ASTM	Coarse Gravel	Fine Gravel	C. Sand	Medium Sand	Fine Sand	Silt	Clay
	0.0	0.0	0.0	0.1	45.9	37.3	16.7

AASHTO	Gravel	Coarse Sand	Fine Sand	Silt	Clay
	0.0	0.1	45.9	41.0	13.0



Comments

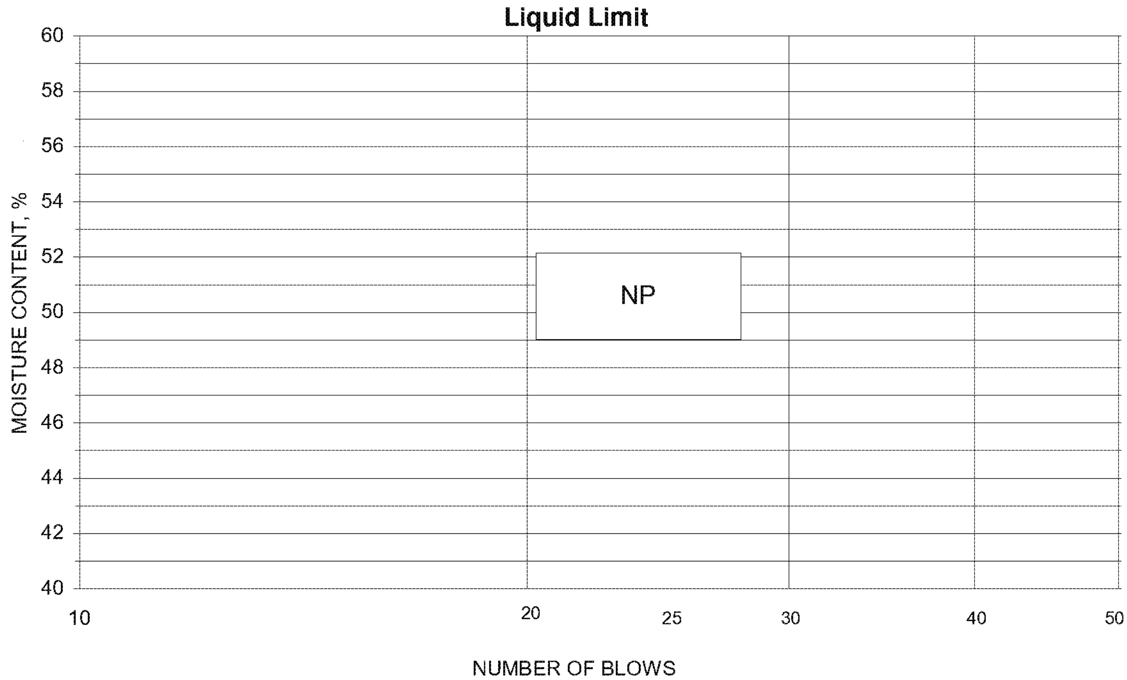
Reviewed By

Stantec

ATTERBERG LIMITS

Project	AEP - Clifty Creek - West Bottom Ash and Fly Ash Ponds subsurface e:	Project No.	175539022
Source	B-5, 55.0'-56.5', 57.5'-59.0'	Lab ID	129
		% + No. 40	0
Tested By	RG	Test Method	ASTM D 4318 Method A
Date Received	11-16-2009		
Test Date	11-23-2009	Prepared	Dry

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Number of Blows	Water Content (%)	Liquid Limit
					#VALUE!



PLASTIC LIMIT AND PLASTICITY INDEX

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Water Content (%)	Plastic Limit	Plasticity Index
					#VALUE!

Remarks: ______________________

Reviewed By ______________

LANDFILL RUNOFF COLLECTION POND:
2009 GEOTECNICAL EXPLORATION

GeoTesting Express

SPECIFIC GRAVITY TEST

(ASTM D854)

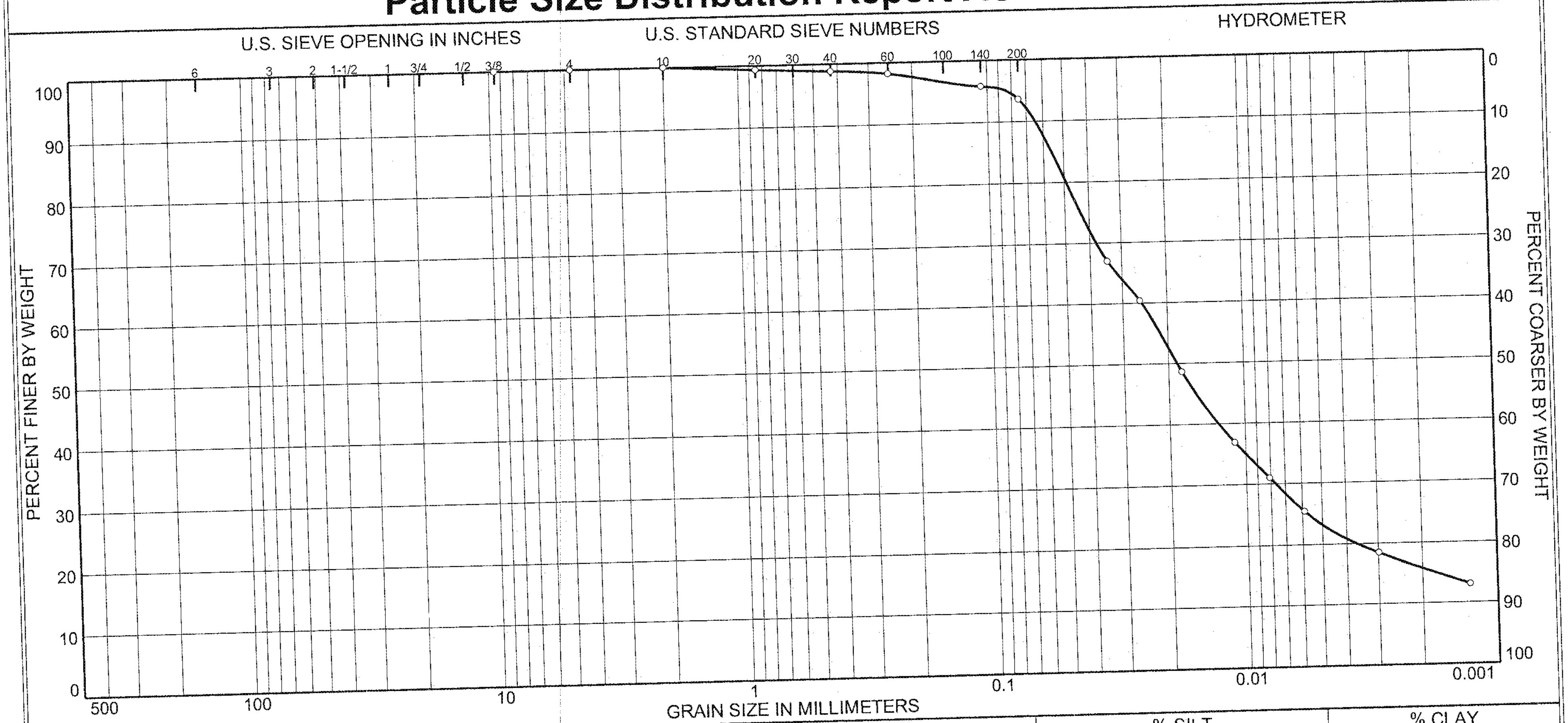
Project No. GTX-1516 Tested By JM Reviewed By MM

Project Name Clifty Creek Test Date 12/8/2009 Review Date 12/13/2009

(1) Boring No.	(2) Depth (ft)	(3) Sample No.	(4) Lab No.	(5) Flask No.	(6) Temperature (°C)	(7) Weight, WF (grams)	(8) Weight, WFS (grams)	(9) Weight of Soil (grams) (8)-(7)	(10) Weight, CWF (grams)	(11) Weight, DS (grams)	(12) Specific Gravity (9)/[(10)-(11)+(9)]	(13) Specific Gravity at 20° C
B-7	27.2-27.8	-	--	41	17	304.60	358.10	53.50	433.68	466.86	2.633	2.634
B-8	25.5-25.8	-	--	33	17	286.35	316.64	30.29	408.76	427.56	2.636	2.638
B-8	29.7-30.3	-	--	34	18	273.88	322.48	48.60	407.64	437.9	2.650	2.651
B-9	30.2-20.8	-	--	40	18	303.59	336.38	32.79	437.43	457.84	2.649	2.650
B-10	14.2-14.8	-	--	29	17	265.69	319.25	53.56	405.05	438.63	2.681	2.682
B-10	16.2-16.8	-	--	29	21	273.96	325.28	51.32	404.86	436.87	2.658	2.657

WF - Water and Flask
WFS - Water, Flask and Soil
CWF - Calibration Water and Flask
DS - Deaired Sample

Particle Size Distribution Report ASTM D422



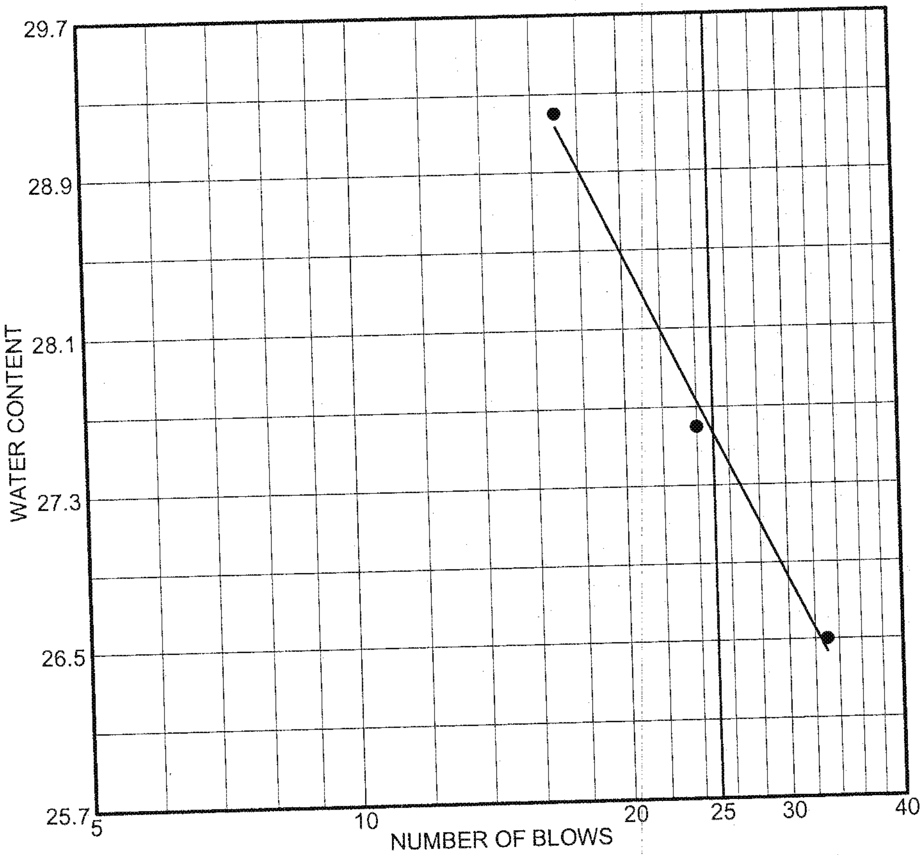
% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.0	6.4	70.4	23.2

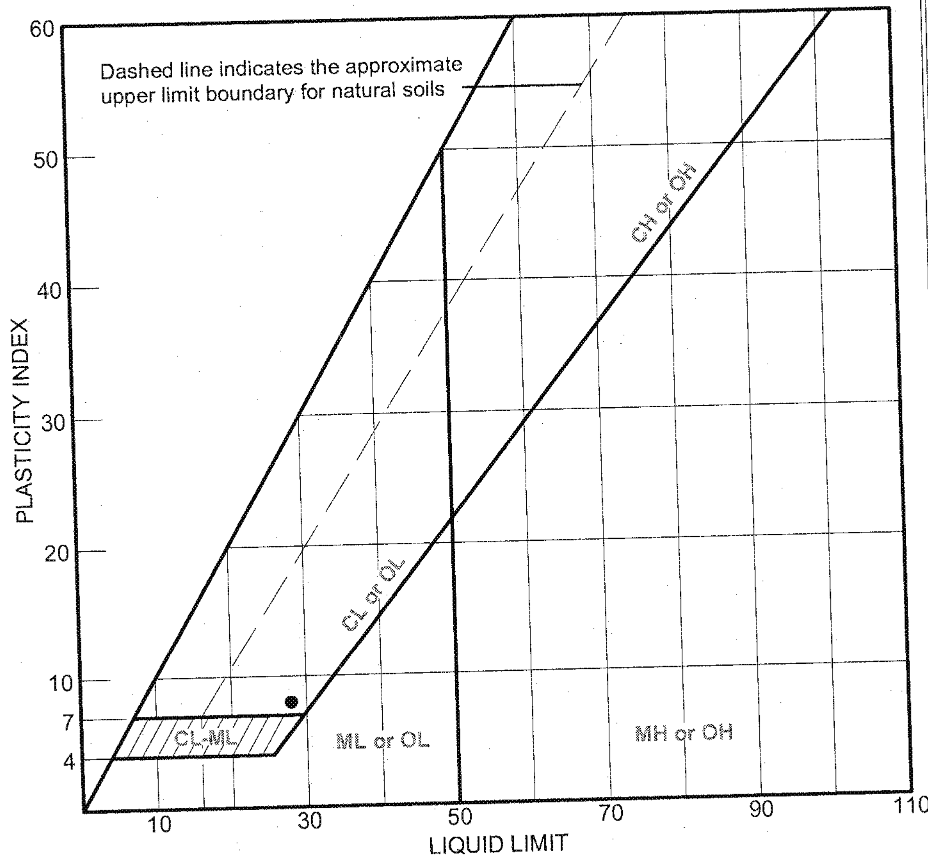
SOURCE	SAMPLE #	DEPTH/ELEV.	DATE SAMPLED	USCS	MATERIAL DESCRIPTION	NM %	LL	PL
	B-7	27.2-27.8 ft	12/10/09	CL	Lean clay		28	20

Client Stantec
Project Clifty Creek
Project No. GTX-1516
Lab no.

GeoTesting Express Inc.

LIQUID AND PLASTIC LIMITS TEST REPORT



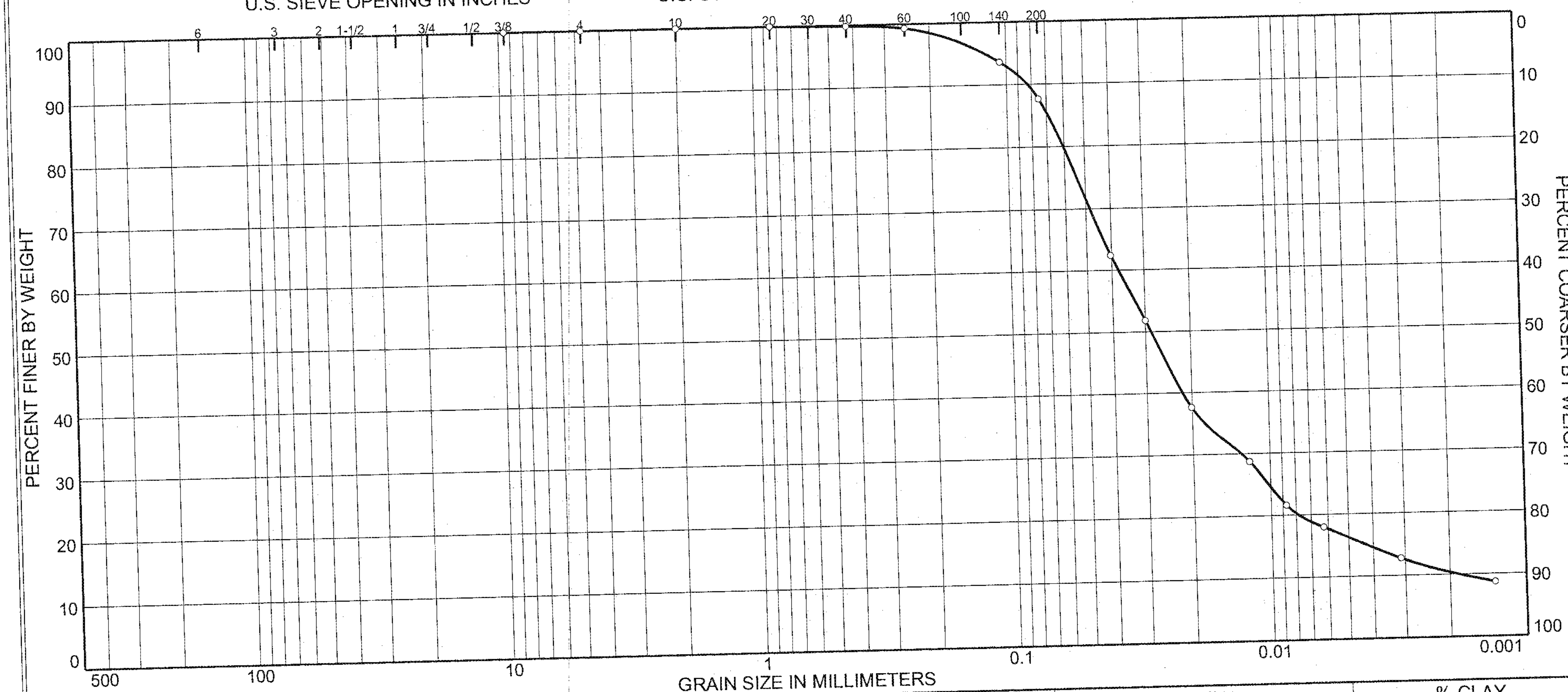


	SOURCE	SAMPLE #	DEPTH/ELEV.	DATE SAMPLED	USCS	MATERIAL DESCRIPTION	NM %	LL	PI
●		B-7	27.2-27.8 ft	12/10/09	CL	Lean clay		28	8

Client Stantec
Project Clifty Creek
Project No. GTX-1516
Lab no.

GeoTesting Express Inc.

Particle Size Distribution Report ASTM D422



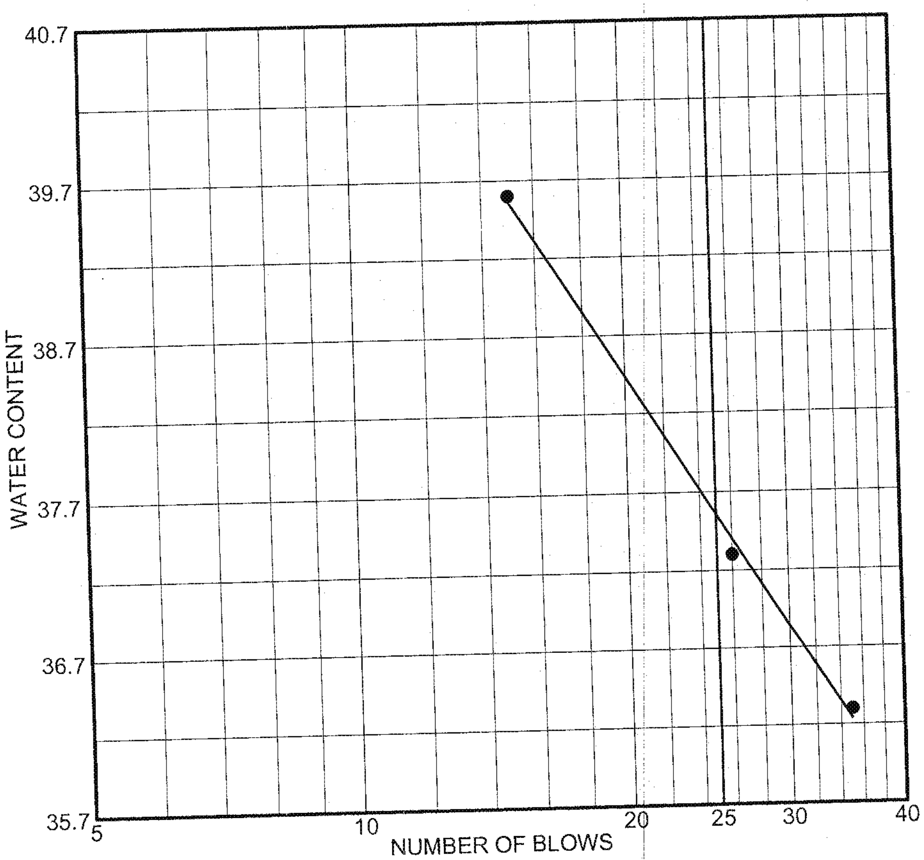
% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.0	12.4	71.3	16.3

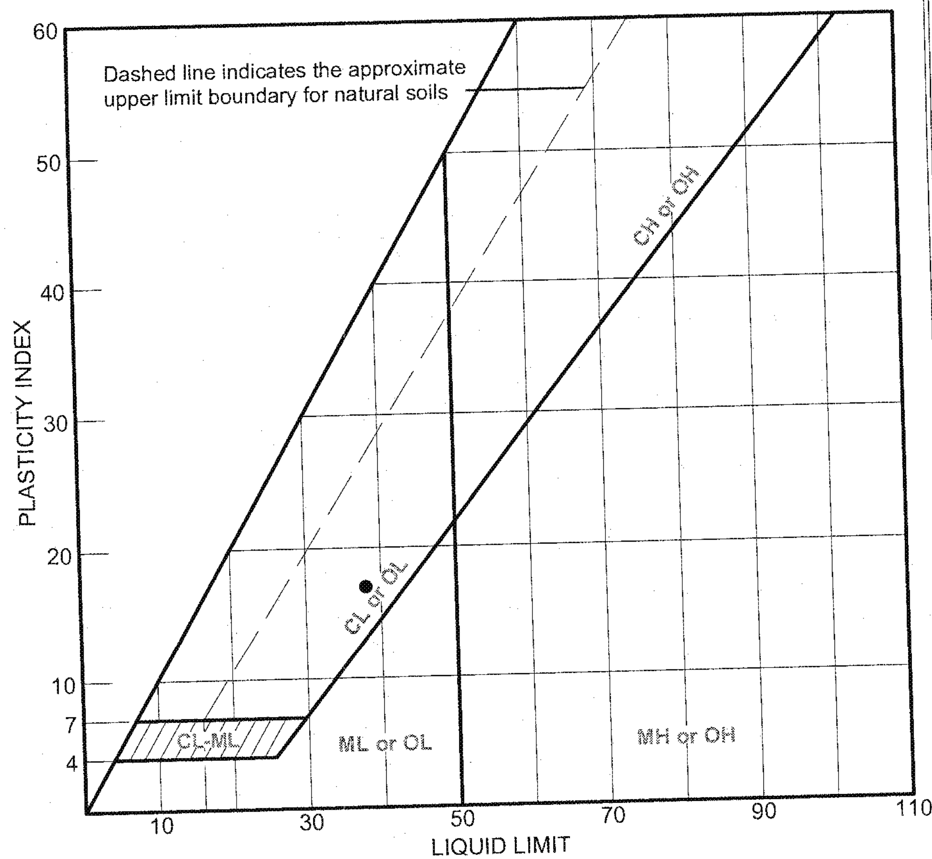
SOURCE	SAMPLE #	DEPTH/ELEV.	DATE SAMPLED	USCS	MATERIAL DESCRIPTION	NM %	LL	PL
	B-8	25.5-25.8 ft	12/10/09	CL	Lean clay		38	21

Client Stantec
Project Clifty Creek
Project No. GTX-1516 Lab no.

GeoTesting Express Inc.

LIQUID AND PLASTIC LIMITS TEST REPORT



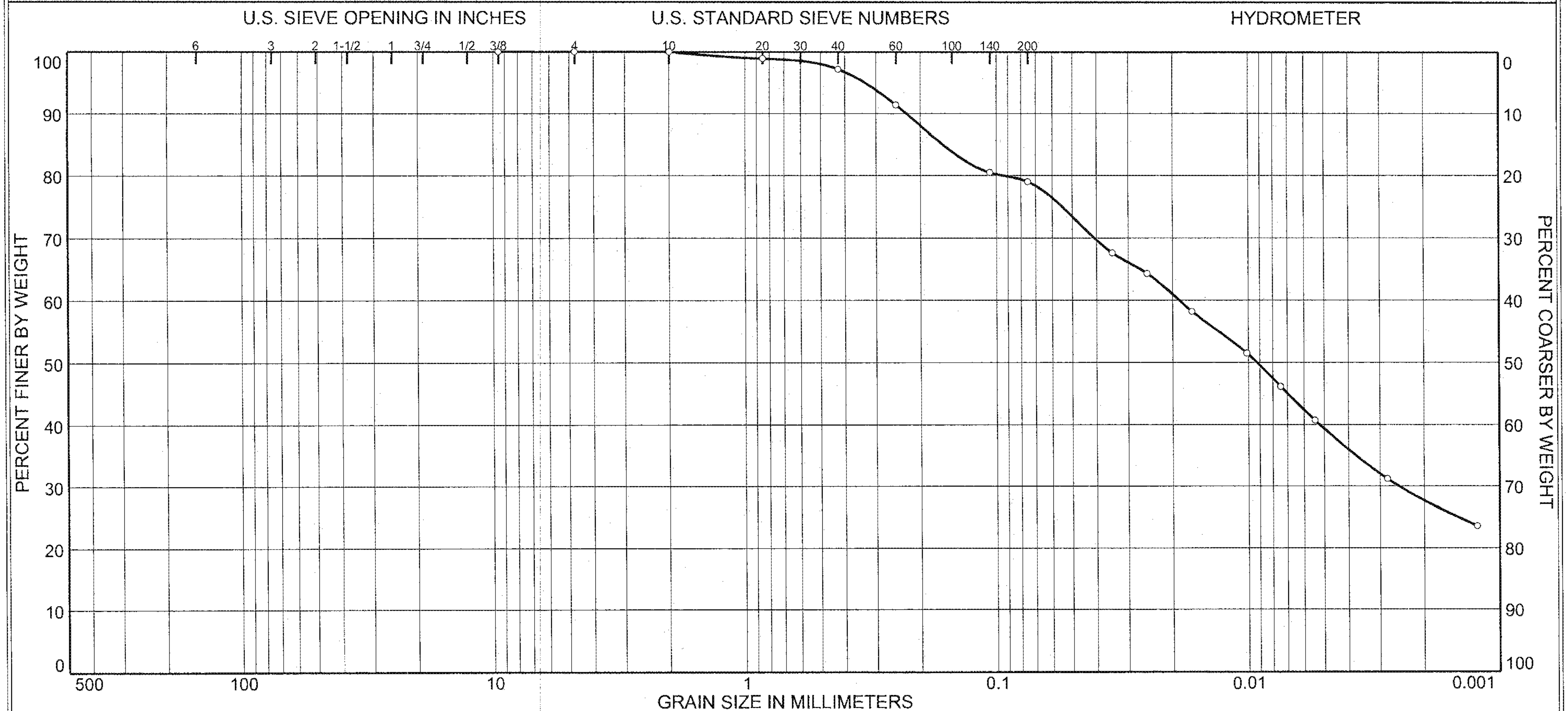


	SOURCE	SAMPLE #	DEPTH/ELEV.	DATE SAMPLED	USCS	MATERIAL DESCRIPTION	NM %	LL	PI
●		B-8	25.5-25.8 ft	12/10/09	CL	Lean clay		38	17

Client Stantec
Project Clifty Creek
Project No. GTX-1516
Lab no.

GeoTesting Express Inc.

Particle Size Distribution Report ASTM D422



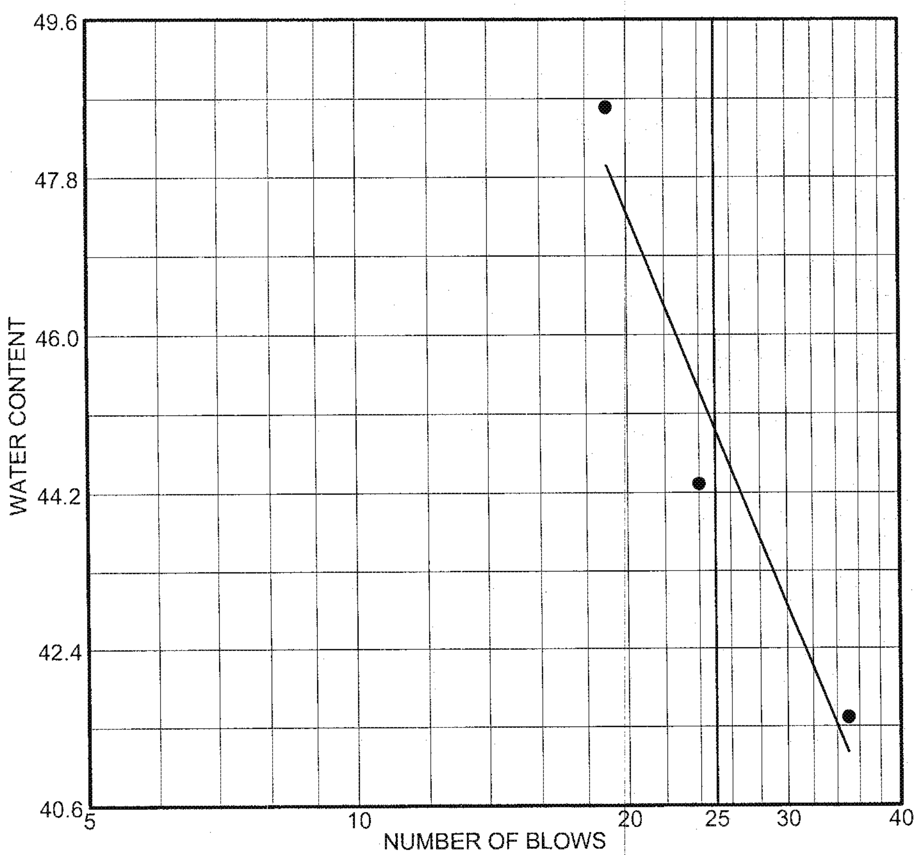
	% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
○	0.0	0.0	21.0	39.6	39.4

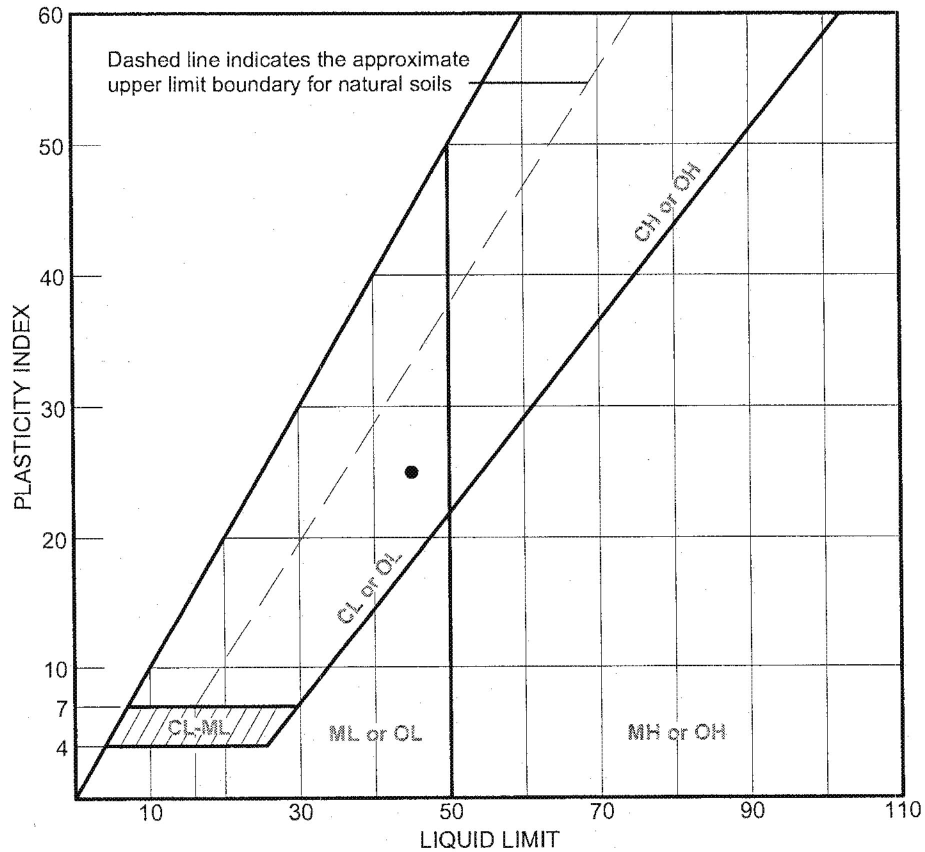
	SOURCE	SAMPLE #	DEPTH/ELEV.	DATE SAMPLED	USCS	MATERIAL DESCRIPTION	NM %	LL	PL
○		B-8	29.7-30.3 ft	12/10/09	CL	Lean clay with sand		45	20

Client Stantec
Project Clifty Creek
Project No. GTX-1516 Lab no.

GeoTesting Express Inc.

LIQUID AND PLASTIC LIMITS TEST REPORT



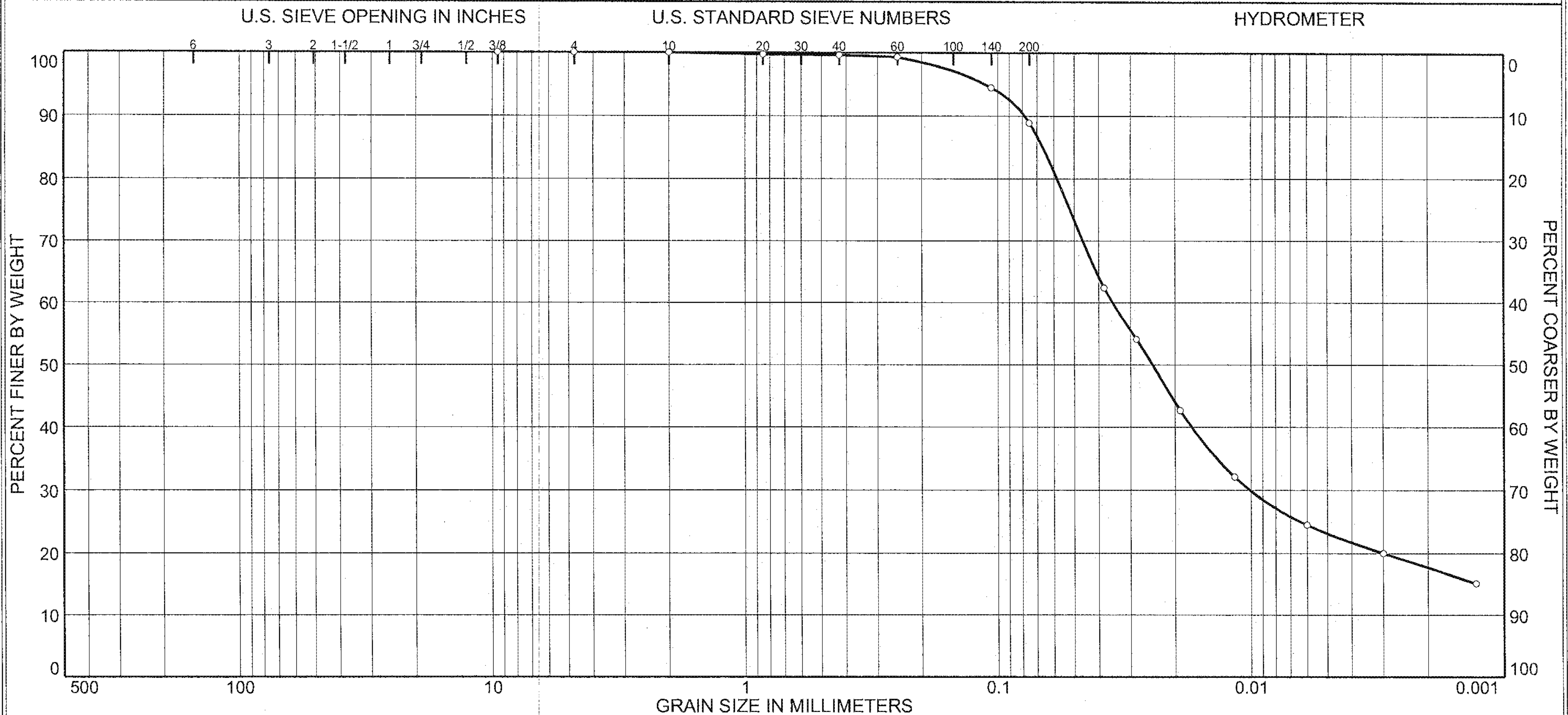


	SOURCE	SAMPLE #	DEPTH/ELEV.	DATE SAMPLED	USCS	MATERIAL DESCRIPTION	NM %	LL	PI
●		B-8	29.7-30.3 ft	12/10/09	CL	Lean clay with sand		45	25

Client Stantec
Project Clifty Creek
Project No. GTX-1516 | Lab no.

GeoTesting Express Inc.

Particle Size Distribution Report ASTM D422



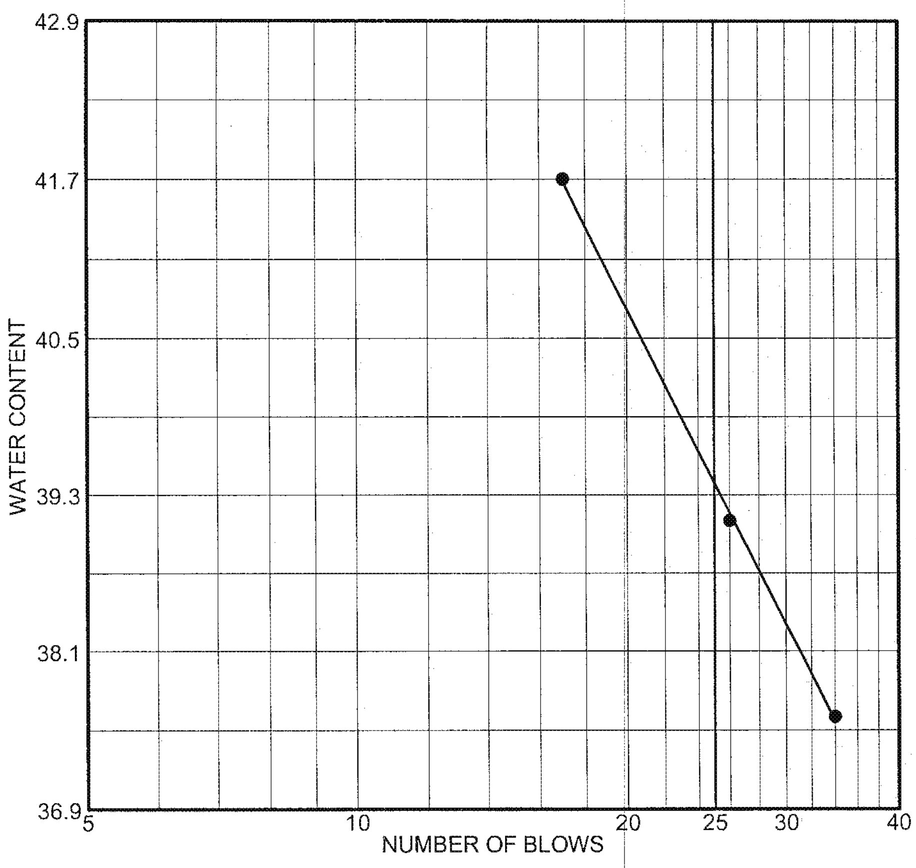
	% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
○	0.0	0.0	11.1	65.8	23.1

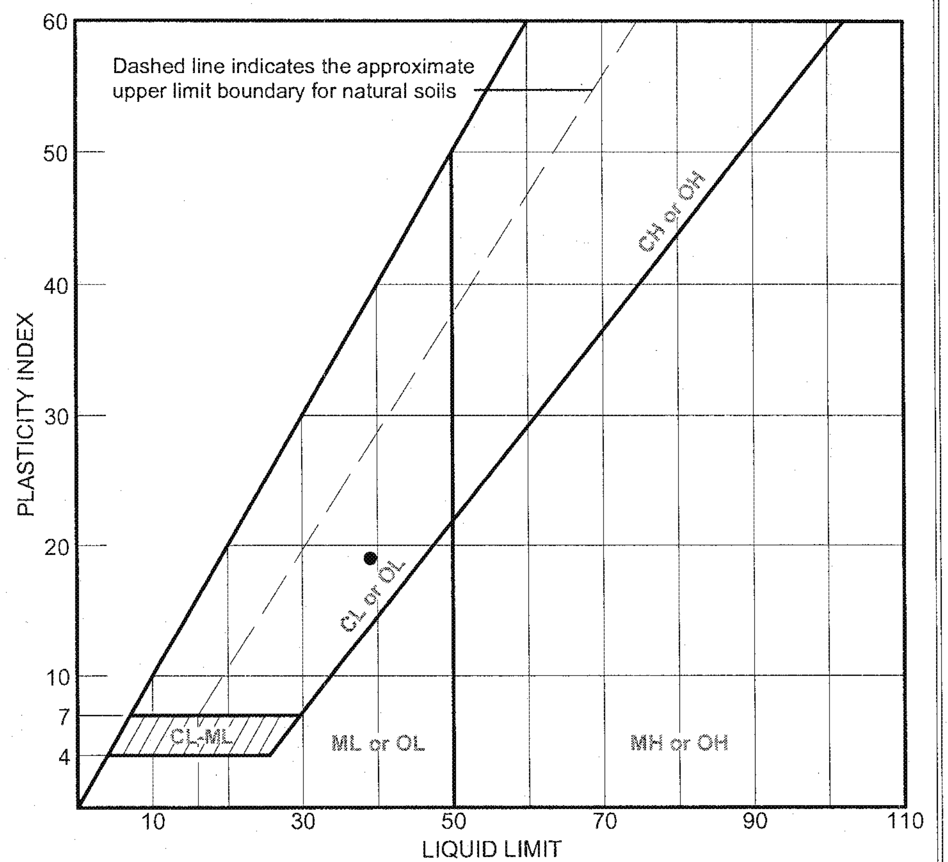
	SOURCE	SAMPLE #	DEPTH/ELEV.	DATE SAMPLED	USCS	MATERIAL DESCRIPTION	NM %	LL	PL
○		B-9	20.2-20.8 ft	12/10/09	CL	Lean clay		39	20

Client Stantec
Project Clifty Creek
Project No. GTX-1516 Lab no.

GeoTesting Express Inc.

LIQUID AND PLASTIC LIMITS TEST REPORT





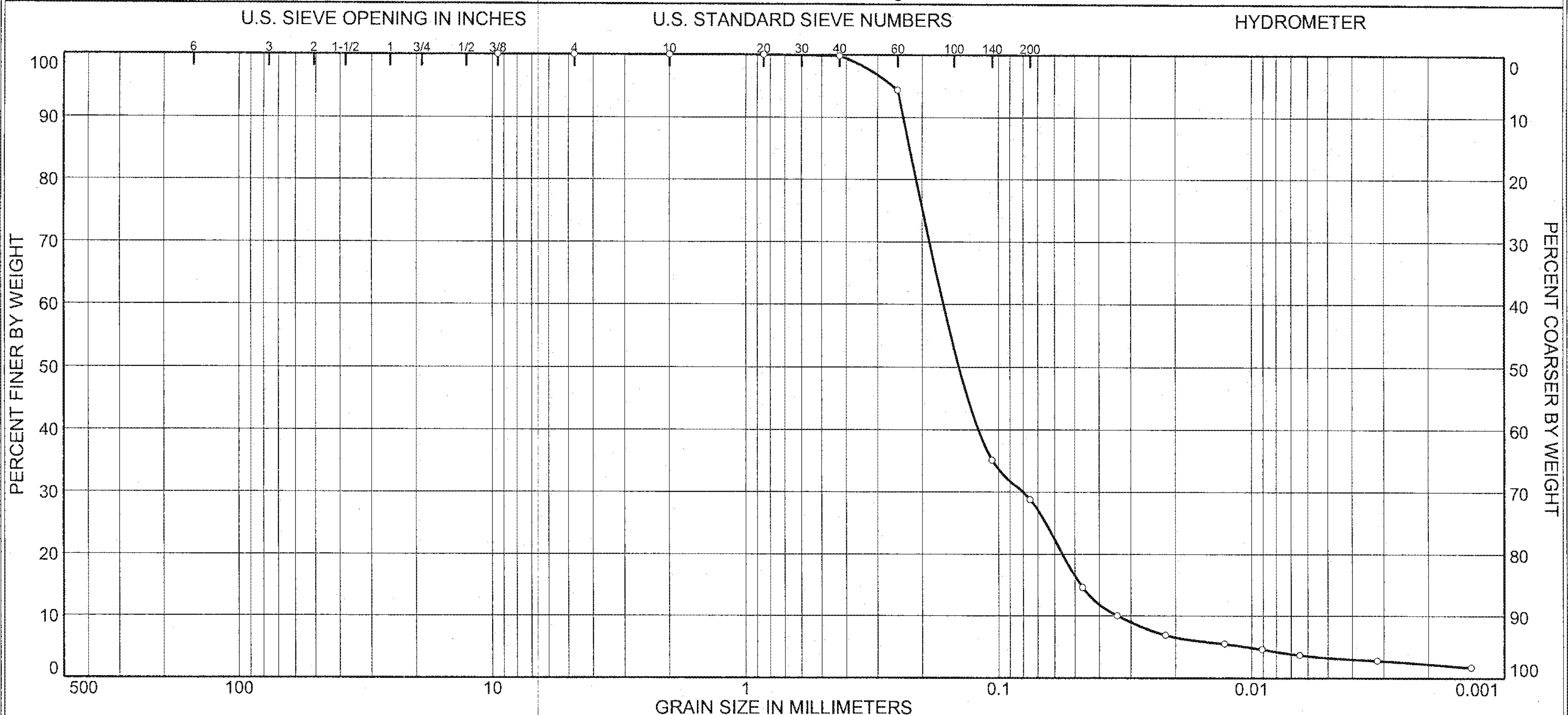
	SOURCE	SAMPLE #	DEPTH/ELEV.	DATE SAMPLED	USCS	MATERIAL DESCRIPTION	NM %	LL	PI
●		B-9	20.2-20.8 ft	12/10/09	CL	Lean clay		39	19

Client Stantec
Project Clifty Creek

Project No. GTX-1516 Lab no.

GeoTesting Express Inc.

Particle Size Distribution Report ASTM D422



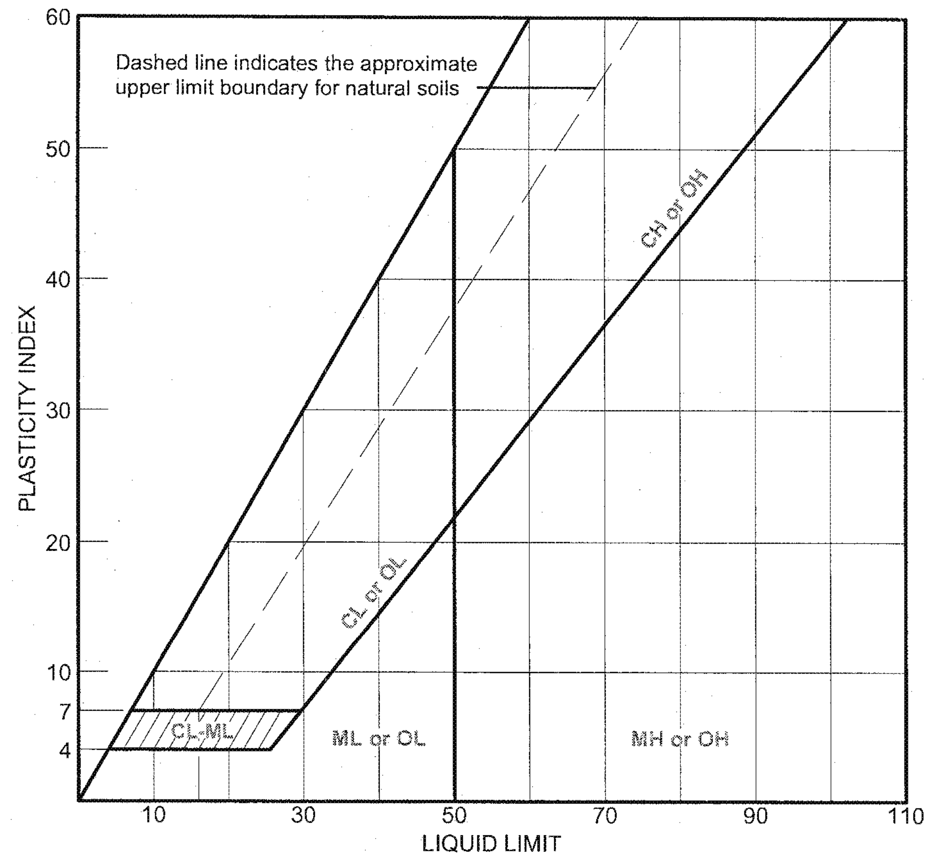
	% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
○	0.0	0.0	71.2	25.5	3.3

	SOURCE	SAMPLE #	DEPTH/ELEV.	DATE SAMPLED	USCS	MATERIAL DESCRIPTION	NM %	LL	PL
○		B-10	14.2-14.8 ft	12/10/09	SM	Silty sand		NV	NP

Client Stantec
Project Clifty Creek
Project No. GTX-1516 Lab no.

GeoTesting Express Inc.

LIQUID AND PLASTIC LIMITS TEST REPORT

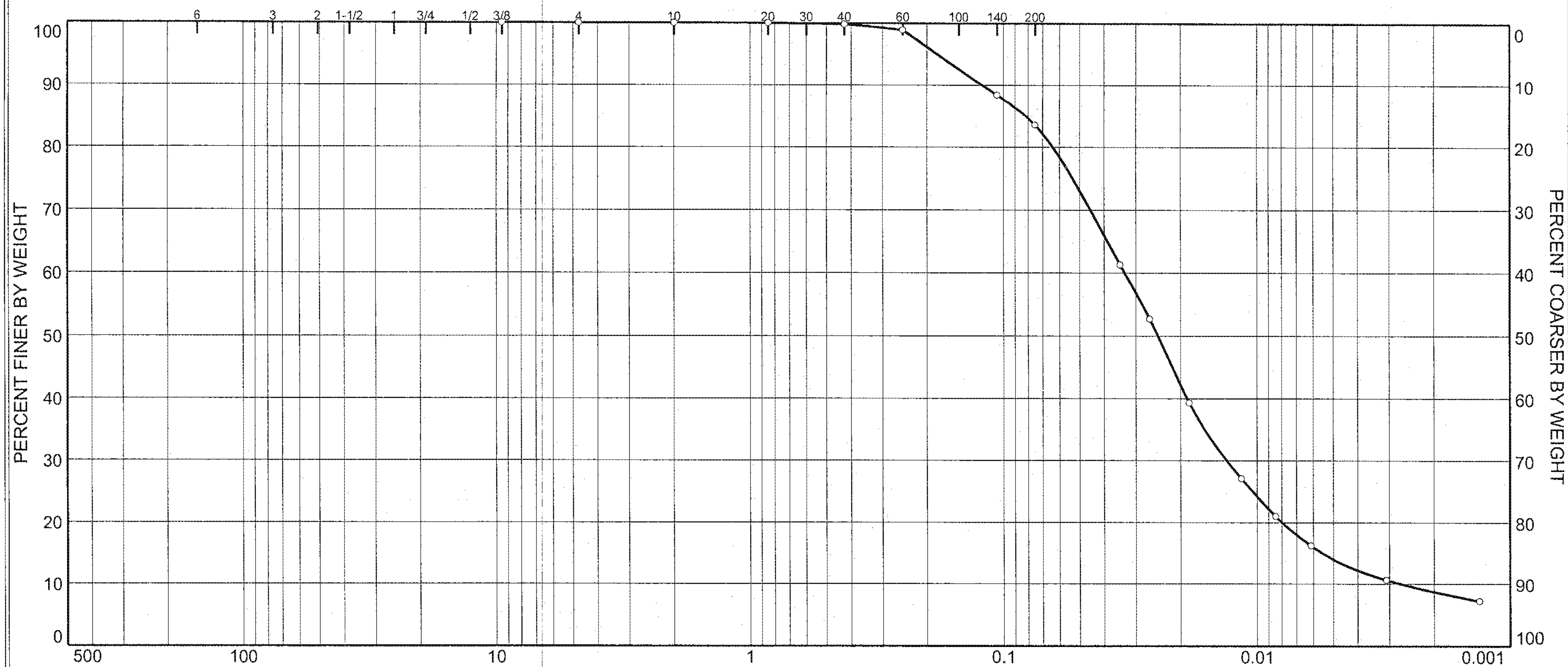


	SOURCE	SAMPLE #	DEPTH/ELEV.	DATE SAMPLED	USCS	MATERIAL DESCRIPTION	NM %	LL	PI
●		B-10	14.2-14.8 ft	12/10/09	SM	Silty sand		NV	NP

Client Stantec
Project Clifty Creek
Project No. GTX-1516 | Lab no.

GeoTesting Express Inc.

Particle Size Distribution Report ASTM D422



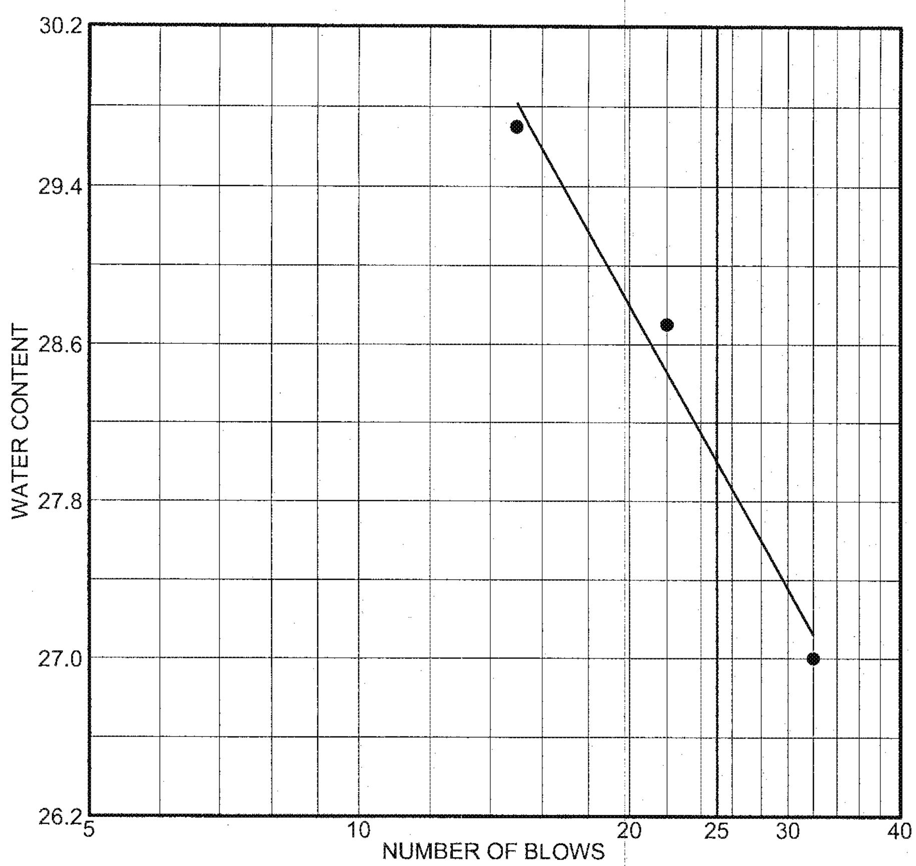
% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.0	16.4	69.7	13.9

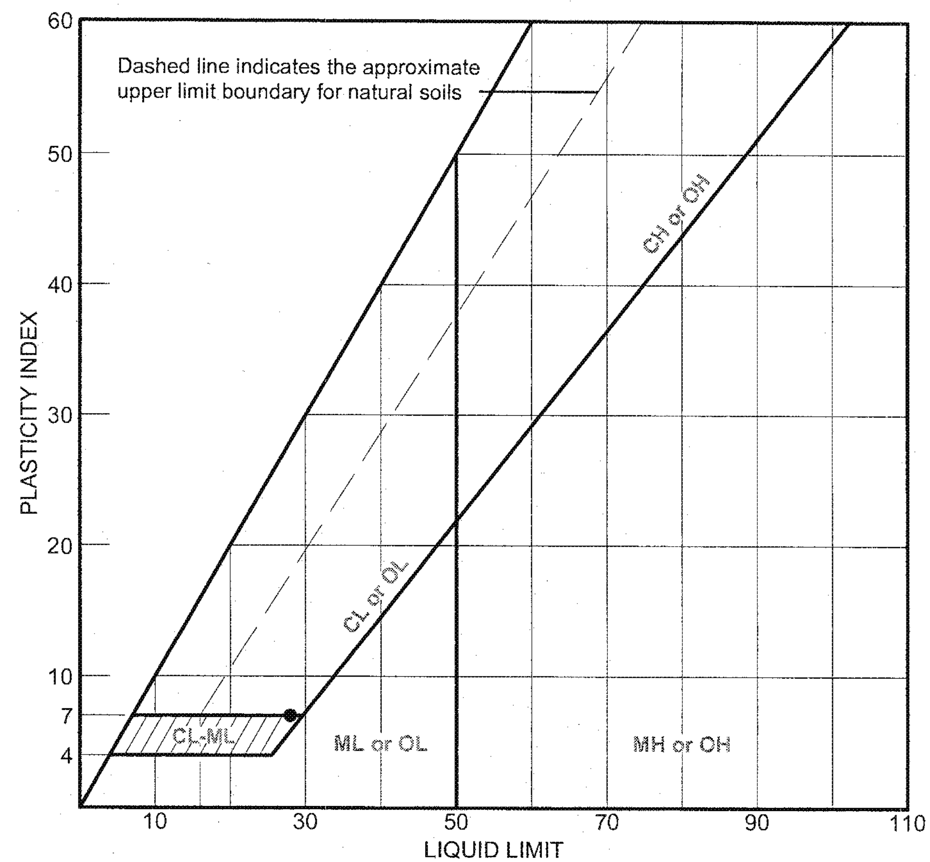
SOURCE	SAMPLE #	DEPTH/ELEV.	DATE SAMPLED	USCS	MATERIAL DESCRIPTION	NM %	LL	PL
	B-10	16.2-16.8 ft	12/10/09	CL-ML	Silty clay with sand		28	21

Client Stantec
Project Clifty Creek
Project No. GTX-1516
Lab no.

GeoTesting Express Inc.

LIQUID AND PLASTIC LIMITS TEST REPORT





	SOURCE	SAMPLE #	DEPTH/ELEV.	DATE SAMPLED	USCS	MATERIAL DESCRIPTION	NM %	LL	PI
●		B-10	16.2-16.8 ft	12/10/09	CL-ML	Silty clay with sand		28	7

Client Stantec
Project Clifty Creek
Project No. GTX-1516 Lab no.

GeoTesting Express Inc.

LANDFILL RUNOFF COLLECTION POND:
2015 GEOTECNICAL EXPLORATION

Stantec

Summary of Soil Tests

Project Name	CCR Rule - AEP Clifty Creek	Project Number	175553022
Source	B-12, 10.0'-11.5'	Lab ID	3
Sample Type	SPT	Date Received	7-21-15
		Date Reported	8-3-15

Test Results

Natural Moisture Content
Test Method: ASTM D 2216
Moisture Content (%): 23.1

Particle Size Analysis
Preparation Method: ASTM D 421
Gradation Method: ASTM D 422
Hydrometer Method: ASTM D 422

Particle Size		%
Sieve Size	(mm)	Passing
	N/A	
	N/A	
	N/A	
	N/A	
	N/A	
	N/A	
No. 4	4.75	100.0
No. 10	2	74.7
No. 40	0.425	74.1
No. 200	0.075	71.7
	0.02	54.4
	0.005	30.3
	0.002	21.1
estimated	0.001	17.0

Plus 3 in. material, not included: 0 (%)

Range	ASTM (%)	AASHTO (%)
Gravel	0.0	25.3
Coarse Sand	25.3	0.6
Medium Sand	0.6	---
Fine Sand	2.4	2.4
Silt	41.4	50.6
Clay	30.3	21.1

Atterberg Limits
Test Method: ASTM D 4318 Method A
Prepared: Dry
Liquid Limit: 43
Plastic Limit: 21
Plasticity Index: 22
Activity Index: 1.05

Moisture-Density Relationship
Test Not Performed
Maximum Dry Density (lb/ft^3): N/A
Maximum Dry Density (kg/m^3): N/A
Optimum Moisture Content (%): N/A
Over Size Correction %: N/A

California Bearing Ratio
Test Not Performed
Bearing Ratio (%): N/A
Compacted Dry Density (lb/ft^3): N/A
Compacted Moisture Content (%): N/A

Specific Gravity
Test Method: ASTM D 854
Prepared: Dry
Particle Size: No. 10
Specific Gravity at 20° Celsius: 2.70

Classification
Unified Group Symbol: CL
Group Name: Lean clay with sand
AASHTO Classification: A-7-6 (15)

Comments:

Reviewed By RJ

Stantec

Particle-Size Analysis of Soils
ASTM D 422

Project Name	CCR Rule - AEP Clifty Creek	Project Number	175553022
Source	B-12, 10.0'-11.5'	Lab ID	3

Sieve analysis for the Portion Coarser than the No. 10 Sieve

Test Method: ASTM D 422
Prepared using: ASTM D 421

Particle Shape: Angular
Particle Hardness: Hard and Durable

Tested By: JS
Test Date: 07-24-2015
Date Received: 07-21-2015

Maximum Particle size: No. 4 Sieve

Sieve Size	% Passing
No. 4	100.0
No. 10	74.7

Analysis for the portion Finer than the No. 10 Sieve

Analysis Based on -3 inch fraction only

Specific Gravity: 2.7

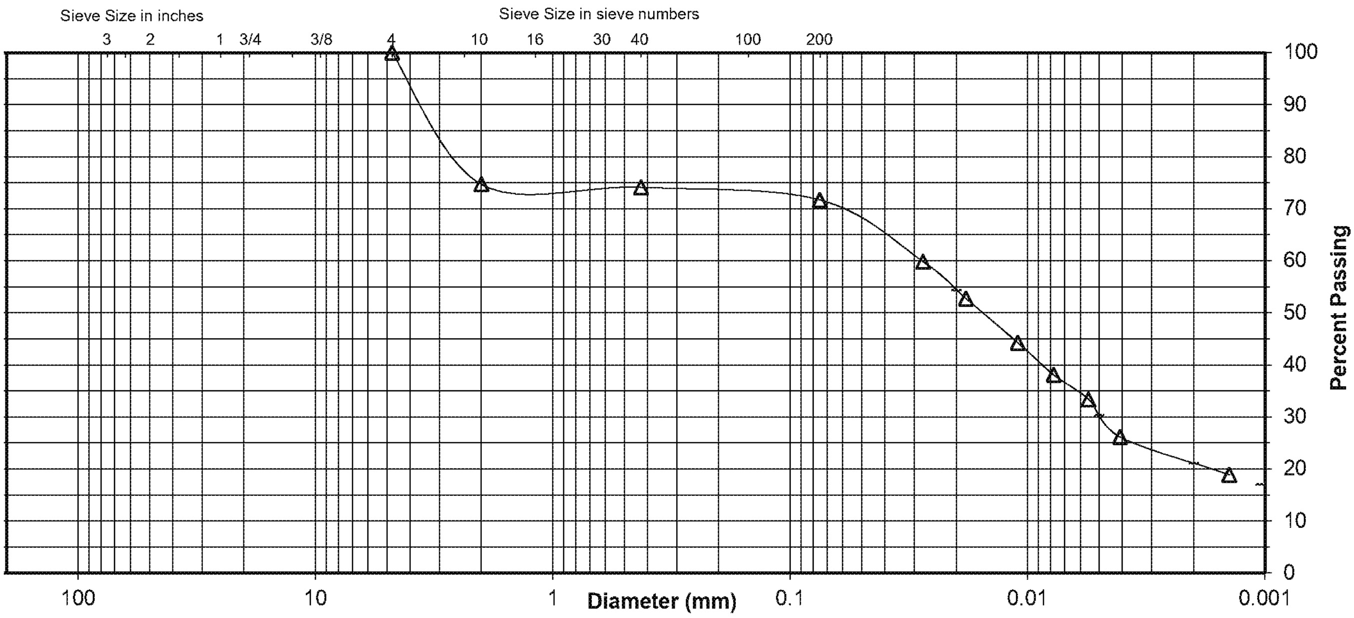
Dispersed using Apparatus A - Mechanical, for 1 minute

No. 40	74.1
No. 200	71.7
0.02 mm	54.4
0.005 mm	30.3
0.002 mm	21.1
0.001 mm	17.0

Particle Size Distribution

ASTM	Coarse Gravel	Fine Gravel	C. Sand	Medium Sand	Fine Sand	Silt	Clay
	0.0	0.0	25.3	0.6	2.4	41.4	30.3

AASHTO	Gravel	Coarse Sand	Fine Sand	Silt	Clay
	25.3	0.6	2.4	50.6	21.1



Comments ______

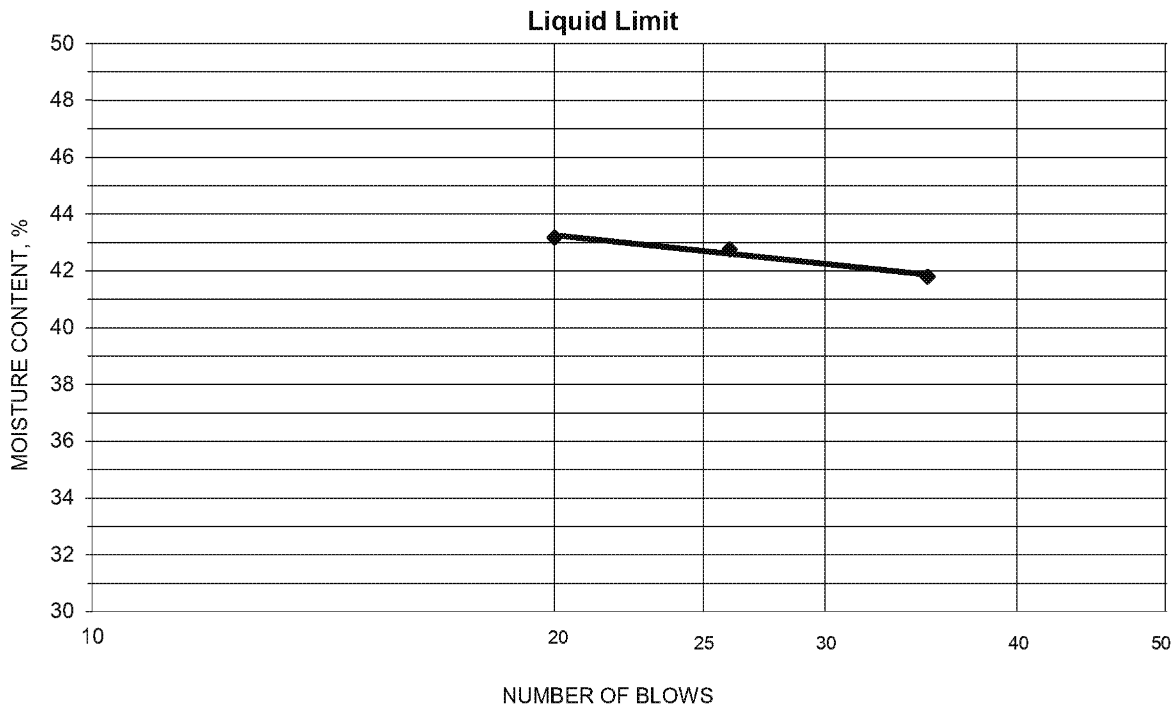
Reviewed By RJ

Stantec

ATTERBERG LIMITS

Project	CCR Rule - AEP Clifty Creek	Project No.	175553022
Source	B-12, 10.0'-11.5'	Lab ID	3
		% + No. 40	26
Tested By	kws	Test Method	ASTM D 4318 Method A
Date Received	07-21-2015		
Test Date	07-27-2015	Prepared	Dry

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Number of Blows	Water Content (%)	Liquid Limit
19.52	17.10	11.31	35	41.8	
18.33	16.09	10.85	26	42.7	
19.57	17.04	11.18	20	43.2	43



PLASTIC LIMIT AND PLASTICITY INDEX

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Water Content (%)	Plastic Limit	Plasticity Index
18.01	16.88	11.47	20.9	21	22
17.57	16.44	11.11	21.2		

Remarks:

Reviewed By RJ

Stantec

Summary of Soil Tests

Project Name	CCR Rule - AEP Clifty Creek	Project Number	175553022
Source	B-12, 30.0'-31.5'	Lab ID	7
Sample Type	SPT	Date Received	7-21-15
		Date Reported	8-3-15

Test Results

Natural Moisture Content
Test Method: ASTM D 2216
Moisture Content (%): 19.0

Particle Size Analysis
Preparation Method: ASTM D 421
Gradation Method: ASTM D 422
Hydrometer Method: ASTM D 422

Particle Size Sieve Size	(mm)	% Passing
	N/A	
	N/A	
	N/A	
	N/A	
3/4"	19	100.0
3/8"	9.5	99.8
No. 4	4.75	89.2
No. 10	2	77.8
No. 40	0.425	77.3
No. 200	0.075	71.4
	0.02	42.9
	0.005	21.6
	0.002	15.2
estimated	0.001	12.0

Plus 3 in. material, not included: 0 (%)

Range	ASTM (%)	AASHTO (%)
Gravel	10.8	22.2
Coarse Sand	11.4	0.5
Medium Sand	0.5	---
Fine Sand	5.9	5.9
Silt	49.8	56.2
Clay	21.6	15.2

Atterberg Limits
Test Method: ASTM D 4318 Method A
Prepared: Dry
Liquid Limit: 31
Plastic Limit: 18
Plasticity Index: 13
Activity Index: 0.87

Moisture-Density Relationship
Test Not Performed
Maximum Dry Density (lb/ft^3): N/A
Maximum Dry Density (kg/m^3): N/A
Optimum Moisture Content (%): N/A
Over Size Correction %: N/A

California Bearing Ratio
Test Not Performed
Bearing Ratio (%): N/A
Compacted Dry Density (lb/ft^3): N/A
Compacted Moisture Content (%): N/A

Specific Gravity
Test Method: ASTM D 854
Prepared: Dry
Particle Size: No. 10
Specific Gravity at 20° Celsius: 2.68

Classification
Unified Group Symbol: CL
Group Name: Lean clay with sand
AASHTO Classification: A-6 (7)

Comments:

Reviewed By RJ

File: frm_175553022_sum_7.xlsm
Preparation Date: 1998
Revision Date: 1-2008

Stantec Consulting Services Inc.
Lexington, Kentucky

Laboratory Document
Prepared By: MW
Approved BY: TLK

Stantec

Particle-Size Analysis of Soils
ASTM D 422

Project Name	CCR Rule - AEP Clifty Creek	Project Number	175553022
Source	B-12, 30.0'-31.5'	Lab ID	7

Sieve analysis for the Portion Coarser than the No. 10 Sieve

Test Method: ASTM D 422
Prepared using: ASTM D 421

Particle Shape: Angular
Particle Hardness: Hard and Durable

Tested By: JS
Test Date: 07-24-2015
Date Received: 07-21-2015

Maximum Particle size: 3/4" Sieve

Sieve Size	% Passing
3/4"	100.0
3/8"	99.8
No. 4	89.2
No. 10	77.8

Analysis for the portion Finer than the No. 10 Sieve

Analysis Based on -3 inch fraction only

Specific Gravity: 2.68

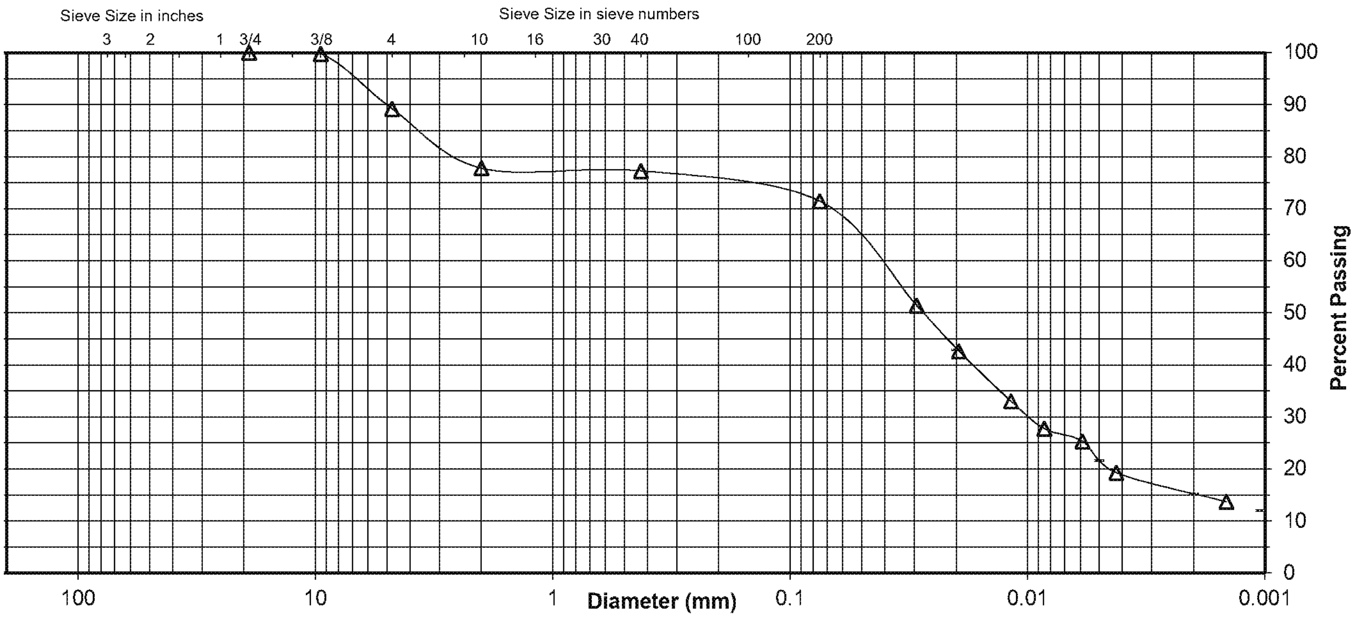
Dispersed using Apparatus A - Mechanical, for 1 minute

No. 40	77.3
No. 200	71.4
0.02 mm	42.9
0.005 mm	21.6
0.002 mm	15.2
0.001 mm	12.0

Particle Size Distribution

ASTM	Coarse Gravel	Fine Gravel	C. Sand	Medium Sand	Fine Sand	Silt	Clay
	0.0	10.8	11.4	0.5	5.9	49.8	21.6

AASHTO	Gravel	Coarse Sand	Fine Sand	Silt	Clay
	22.2	0.5	5.9	56.2	15.2



Comments ______

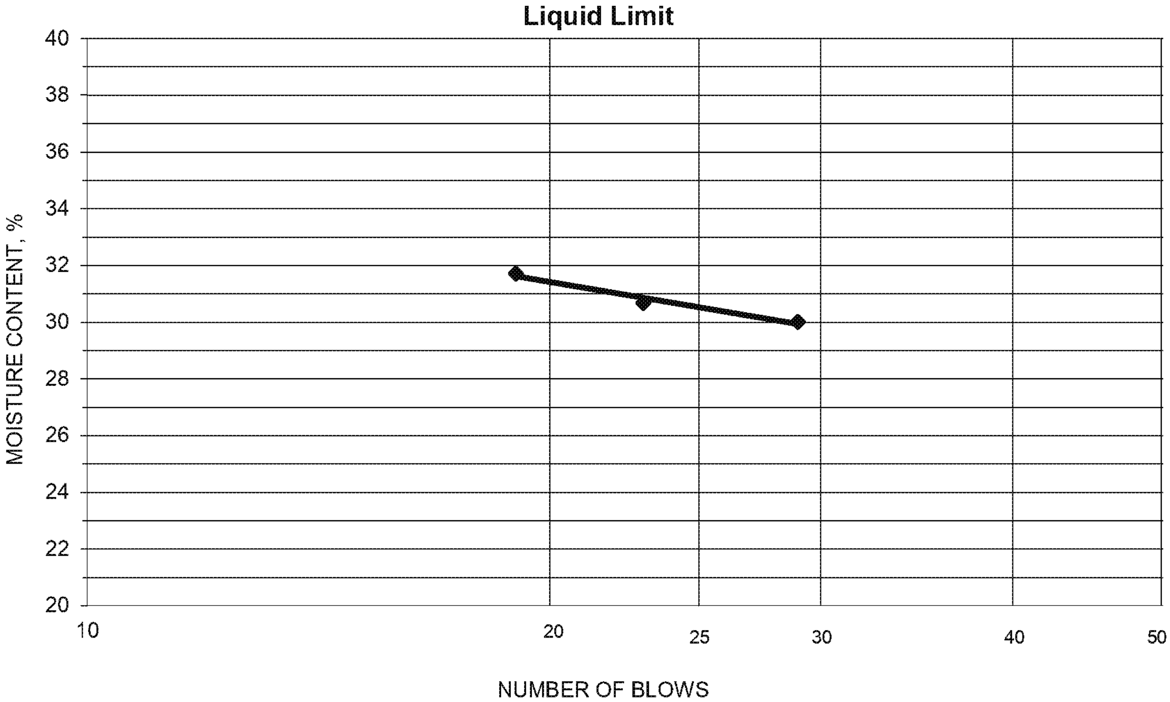
Reviewed By RJ

Stantec

ATTERBERG LIMITS

Project	CCR Rule - AEP Clifty Creek	Project No.	175553022
Source	B-12, 30.0'-31.5'	Lab ID	7
		% + No. 40	23
Tested By	KG	Test Method	ASTM D 4318 Method A
Date Received	07-21-2015		
Test Date	07-31-2015	Prepared	Dry

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Number of Blows	Water Content (%)	Liquid Limit
19.80	17.75	10.92	29	30.0	31
19.72	17.68	11.03	23	30.7	
20.84	18.48	11.04	19	31.7	



PLASTIC LIMIT AND PLASTICITY INDEX

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Water Content (%)	Plastic Limit	Plasticity Index
19.95	18.61	11.11	17.9	18	13
20.10	18.75	11.18	17.8		

Remarks:

Reviewed By RJ

Stantec

Summary of Soil Tests

Project Name	CCR Rule - AEP Clifty Creek	Project Number	175553022
Source	B-12, 45.0'-46.5'	Lab ID	10
Sample Type	SPT	Date Received	7-21-15
		Date Reported	8-3-15

Test Results

Natural Moisture Content

Test Method: ASTM D 2216

Moisture Content (%): 18.7

Particle Size Analysis

Preparation Method: ASTM D 421

Gradation Method: ASTM D 422

Hydrometer Method: ASTM D 422

Particle Size Sieve Size	(mm)	% Passing
	N/A	
	N/A	
	N/A	
	N/A	
	N/A	
	N/A	
No. 4	4.75	100.0
No. 10	2	99.3
No. 40	0.425	99.2
No. 200	0.075	82.2
	0.02	34.0
	0.005	14.0
	0.002	10.7
estimated	0.001	10.0

Plus 3 in. material, not included: 0 (%)

Range	ASTM (%)	AASHTO (%)
Gravel	0.0	0.7
Coarse Sand	0.7	0.1
Medium Sand	0.1	---
Fine Sand	17.0	17.0
Silt	68.2	71.5
Clay	14.0	10.7

Atterberg Limits

Test Method: ASTM D 4318 Method A

Prepared: Dry

Liquid Limit: 26

Plastic Limit: 19

Plasticity Index: 7

Activity Index: 0.64

Moisture-Density Relationship

Test Not Performed

Maximum Dry Density (lb/ft^3): N/A

Maximum Dry Density (kg/m^3): N/A

Optimum Moisture Content (%): N/A

Over Size Correction %: N/A

California Bearing Ratio

Test Not Performed

Bearing Ratio (%): N/A

Compacted Dry Density (lb/ft^3): N/A

Compacted Moisture Content (%): N/A

Specific Gravity

Test Method: ASTM D 854

Prepared: Dry

Particle Size: No. 10

Specific Gravity at 20° Celsius: 2.72

Classification

Unified Group Symbol: CL-ML

Group Name: Silty clay with sand

AASHTO Classification: A-4 (4)

Comments:

Reviewed By RJ

Stantec Consulting Services Inc.
Lexington, Kentucky

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Particle-Size Analysis of Soils
ASTM D 422

Project Name	CCR Rule - AEP Clifty Creek	Project Number	175553022
Source	B-12, 45.0'-46.5'	Lab ID	10

Sieve analysis for the Portion Coarser than the No. 10 Sieve

Test Method ASTM D 422
Prepared using ASTM D 421

Particle Shape Angular
Particle Hardness: Hard and Durable

Tested By JS
Test Date 07-24-2015
Date Received 07-21-2015

Maximum Particle size: No. 4 Sieve

Sieve Size	% Passing
No. 4	100.0
No. 10	99.3

Analysis for the portion Finer than the No. 10 Sieve

Analysis Based on -3 inch fraction only

Specific Gravity 2.72

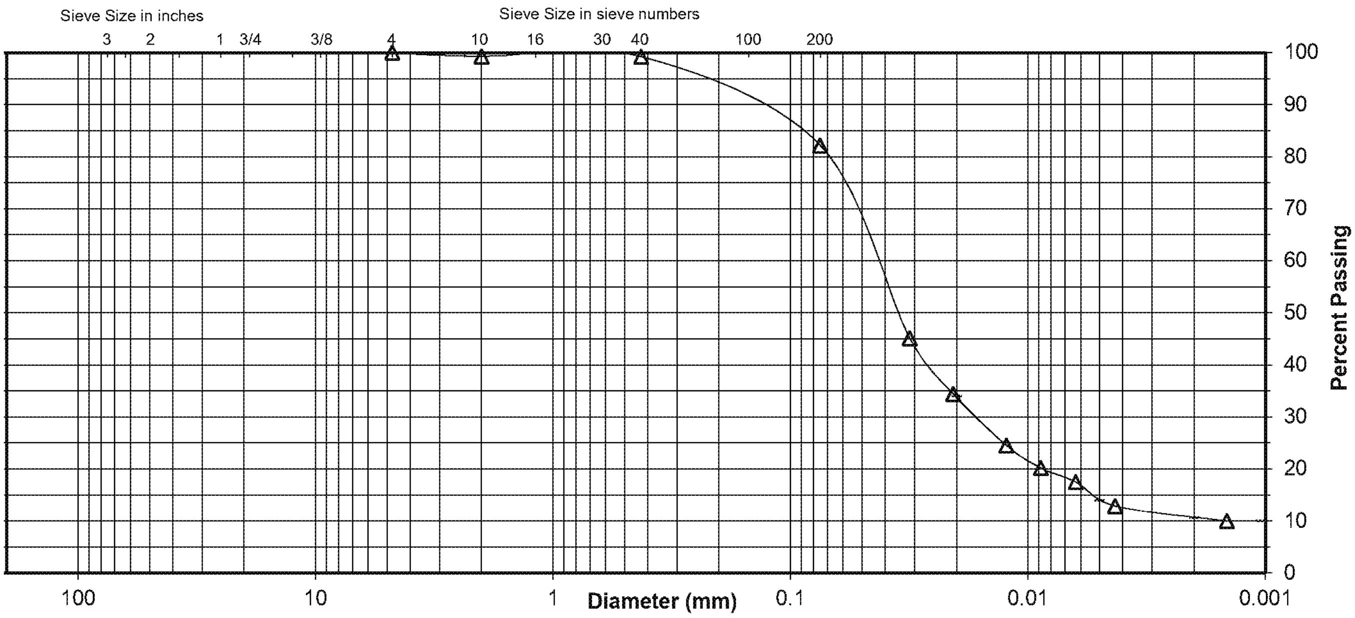
Dispersed using Apparatus A - Mechanical, for 1 minute

No. 40	99.2
No. 200	82.2
0.02 mm	34.0
0.005 mm	14.0
0.002 mm	10.7
0.001 mm	10.0

Particle Size Distribution

ASTM	Coarse Gravel	Fine Gravel	C. Sand	Medium Sand	Fine Sand	Silt	Clay
	0.0	0.0	0.7	0.1	17.0	68.2	14.0

AASHTO	Gravel	Coarse Sand	Fine Sand	Silt	Clay
	0.7	0.1	17.0	71.5	10.7



Comments ______

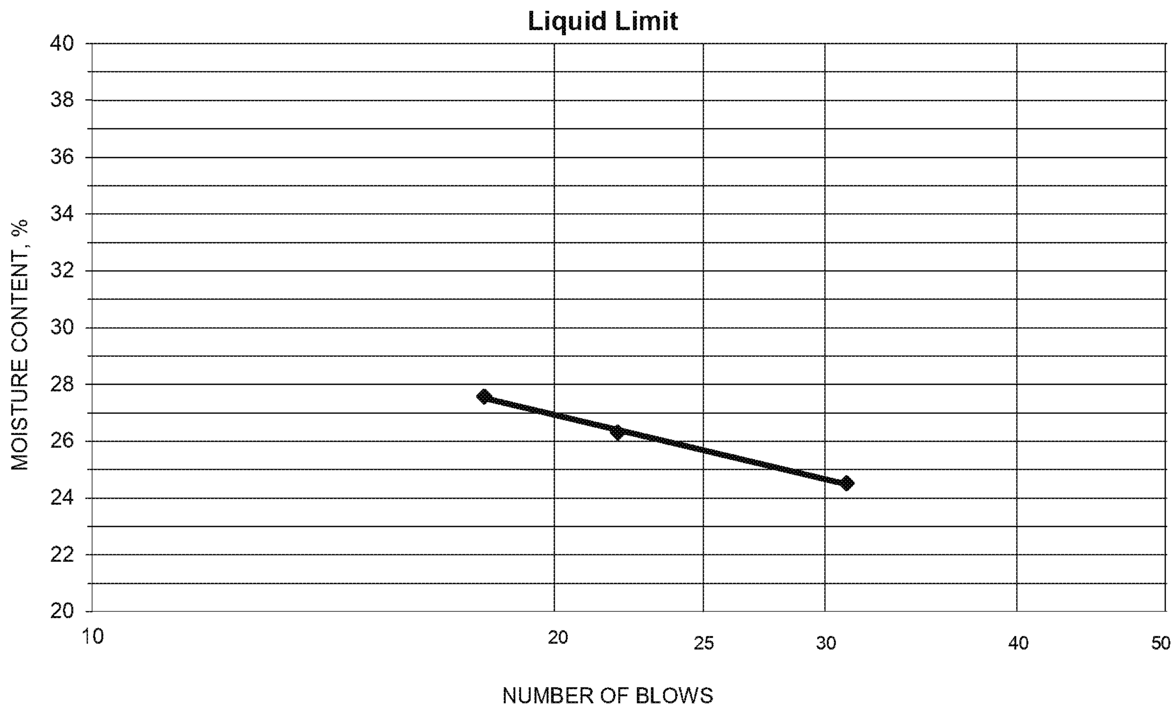
Reviewed By RJ

Stantec

ATTERBERG LIMITS

Project	CCR Rule - AEP Clifty Creek	Project No.	175553022
Source	B-12, 45.0'-46.5'	Lab ID	10
		% + No. 40	1
Tested By	TA	Test Method	ASTM D 4318 Method A
Date Received	07-21-2015		
Test Date	07-30-2015	Prepared	Dry

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Number of Blows	Water Content (%)	Liquid Limit
19.13	17.46	11.11	22	26.3	26
21.65	19.32	10.87	18	27.6	
22.47	20.32	11.55	31	24.5	



PLASTIC LIMIT AND PLASTICITY INDEX

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Water Content (%)	Plastic Limit	Plasticity Index
17.45	16.47	11.42	19.4	19	7
17.70	16.74	11.60	18.7		

Remarks:

Reviewed By RJ

Stantec

Summary of Soil Tests

Project Name	CCR Rule - AEP Clifty Creek	Project Number	175553022
Source	B-12, 50.0'-51.5'	Lab ID	11
Sample Type	SPT	Date Received	7-21-15
		Date Reported	8-3-15

Test Results

Natural Moisture Content

Test Method: ASTM D 2216

Moisture Content (%): 21.9

Particle Size Analysis

Preparation Method: ASTM D 421

Gradation Method: ASTM D 422

Hydrometer Method: ASTM D 422

Particle Size		%
Sieve Size	(mm)	Passing
	N/A	
	N/A	
	N/A	
	N/A	
	N/A	
	N/A	
	N/A	
No. 10	2	100.0
No. 40	0.425	99.8
No. 200	0.075	81.3
	0.02	29.1
	0.005	6.3
	0.002	3.2
estimated	0.001	1.0

Plus 3 in. material, not included: 0 (%)

Range	ASTM (%)	AASHTO (%)
Gravel	0.0	0.0
Coarse Sand	0.0	0.2
Medium Sand	0.2	---
Fine Sand	18.5	18.5
Silt	75.0	78.1
Clay	6.3	3.2

Atterberg Limits

Test Method: ASTM D 4318 Method A

Prepared: Dry

Liquid Limit: NP

Plastic Limit: NP

Plasticity Index: NP

Activity Index: N/A

Moisture-Density Relationship

Test Not Performed

Maximum Dry Density (lb/ft^3): N/A

Maximum Dry Density (kg/m^3): N/A

Optimum Moisture Content (%): N/A

Over Size Correction %: N/A

California Bearing Ratio

Test Not Performed

Bearing Ratio (%): N/A

Compacted Dry Density (lb/ft^3): N/A

Compacted Moisture Content (%): N/A

Specific Gravity

Test Method: ASTM D 854

Prepared: Dry

Particle Size: No. 10

Specific Gravity at 20° Celsius: 2.68

Classification

Unified Group Symbol: ML

Group Name: Silt with sand

AASHTO Classification: A-4 (0)

Comments:

Reviewed By RJ

Stantec

Particle-Size Analysis of Soils
ASTM D 422

Project Name	CCR Rule - AEP Clifty Creek	Project Number	175553022
Source	B-12, 50.0'-51.5'	Lab ID	11

Sieve analysis for the Portion Coarser than the No. 10 Sieve

Test Method: ASTM D 422
Prepared using: ASTM D 421

Particle Shape: N/A
Particle Hardness: N/A

Tested By: JS
Test Date: 07-24-2015
Date Received: 07-21-2015

Maximum Particle size: No. 10 Sieve

Sieve Size	% Passing
No. 10	100.0

Analysis for the portion Finer than the No. 10 Sieve

Analysis Based on -3 inch fraction only

Specific Gravity: 2.68

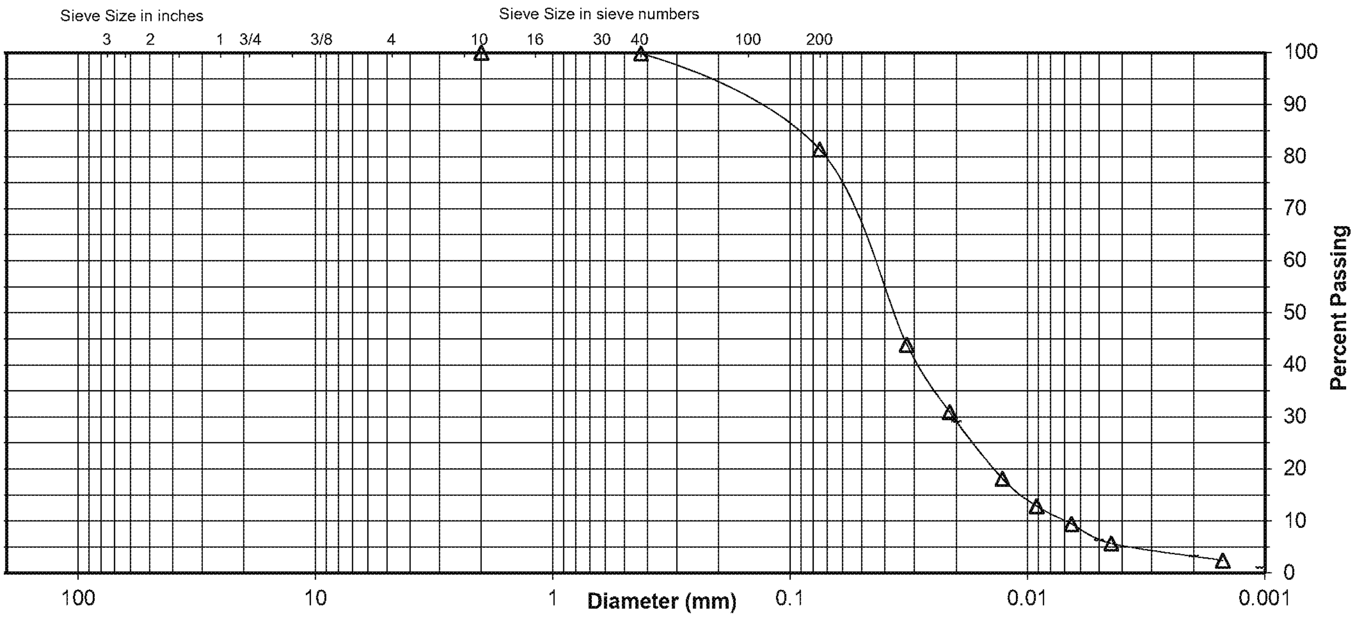
Dispersed using Apparatus A - Mechanical, for 1 minute

No. 40	99.8
No. 200	81.3
0.02 mm	29.1
0.005 mm	6.3
0.002 mm	3.2
0.001 mm	1.0

Particle Size Distribution

ASTM	Coarse Gravel	Fine Gravel	C. Sand	Medium Sand	Fine Sand	Silt	Clay
	0.0	0.0	0.0	0.2	18.5	75.0	6.3

AASHTO	Gravel	Coarse Sand	Fine Sand	Silt	Clay
	0.0	0.2	18.5	78.1	3.2



Comments ______

Reviewed By RJ

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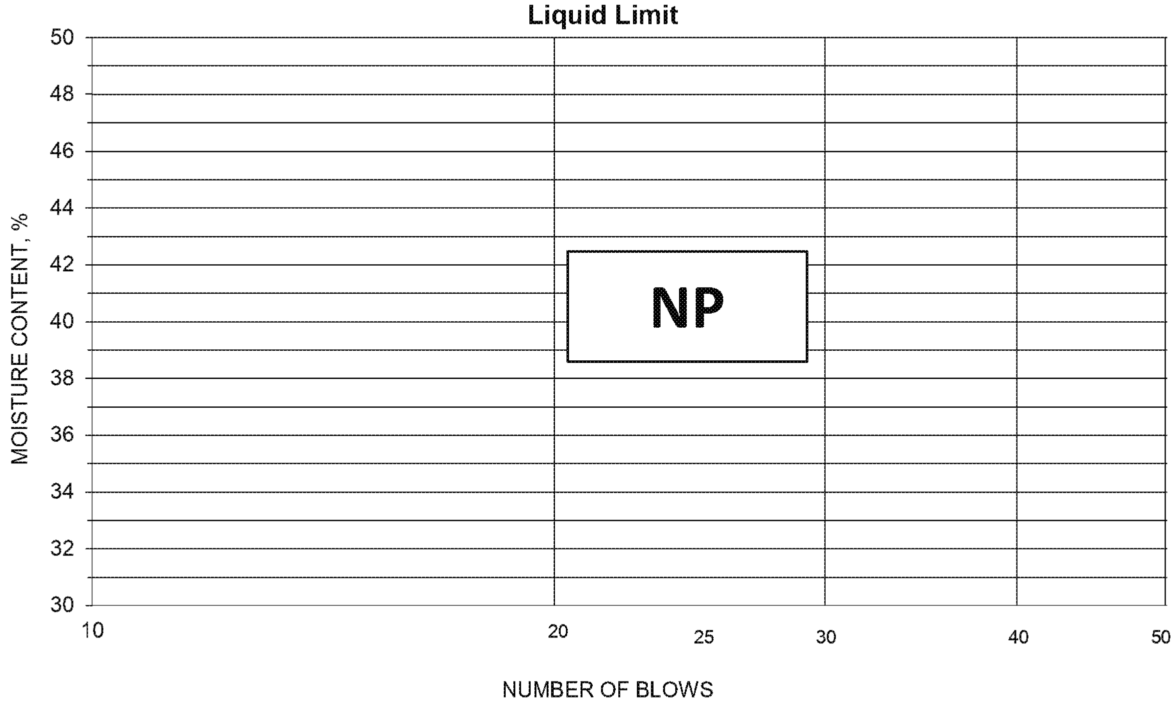
ATTERBERG LIMITS

Project	CCR Rule - AEP Clifty Creek	Project No.	175553022
Source	B-12, 50.0'-51.5'	Lab ID	11
		% + No. 40	0
Tested By	TA	Test Method	ASTM D 4318 Method A
Date Received	07-21-2015		
Test Date	07-30-2015	Prepared	Dry

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Number of Blows	Water Content (%)	Liquid Limit

Liquid Limit



PLASTIC LIMIT AND PLASTICITY INDEX

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Water Content (%)	Plastic Limit	Plasticity Index

Remarks:

Reviewed By RJ

Stantec

Summary of Soil Tests

Project Name	CCR Rule - AEP Clifty Creek	Project Number	175553022
Source	B-12, 60.0'-61.5'	Lab ID	13
Sample Type	SPT	Date Received	7-21-15
		Date Reported	8-3-15

Test Results

Natural Moisture Content

Test Method: ASTM D 2216

Moisture Content (%): 14.8

Particle Size Analysis

Preparation Method: ASTM D 421

Gradation Method: ASTM D 422

Hydrometer Method: ASTM D 422

Particle Size Sieve Size	Particle Size (mm)	% Passing
	N/A	
	N/A	
	N/A	
	N/A	
	N/A	
	N/A	
No. 4	4.75	100.0
No. 10	2	98.5
No. 40	0.425	95.7
No. 200	0.075	36.1
	0.02	12.4
	0.005	5.1
	0.002	2.8
estimated	0.001	1.0

Plus 3 in. material, not included: 0 (%)

Range	ASTM (%)	AASHTO (%)
Gravel	0.0	1.5
Coarse Sand	1.5	2.8
Medium Sand	2.8	---
Fine Sand	59.6	59.6
Silt	31.0	33.3
Clay	5.1	2.8

Atterberg Limits

Test Method: ASTM D 4318 Method A

Prepared: Dry

Liquid Limit: NP

Plastic Limit: NP

Plasticity Index: NP

Activity Index: N/A

Moisture-Density Relationship

Test Not Performed

Maximum Dry Density (lb/ft^3): N/A

Maximum Dry Density (kg/m^3): N/A

Optimum Moisture Content (%): N/A

Over Size Correction %: N/A

California Bearing Ratio

Test Not Performed

Bearing Ratio (%): N/A

Compacted Dry Density (lb/ft^3): N/A

Compacted Moisture Content (%): N/A

Specific Gravity

Test Method: ASTM D 854

Prepared: Dry

Particle Size: No. 10

Specific Gravity at 20° Celsius: 2.75

Classification

Unified Group Symbol: SM

Group Name: Silty sand

AASHTO Classification: A-4 (0)

Comments:

Reviewed By RJ

Stantec

Particle-Size Analysis of Soils
ASTM D 422

Project Name: CCR Rule - AEP Clifty Creek
Project Number: 175553022
Source: B-12, 60.0'-61.5'
Lab ID: 13

Sieve analysis for the Portion Coarser than the No. 10 Sieve

Test Method: ASTM D 422
Prepared using: ASTM D 421

Particle Shape: Angular
Particle Hardness: Hard and Durable

Tested By: JS
Test Date: 07-24-2015
Date Received: 07-21-2015

Maximum Particle size: No. 4 Sieve

Sieve Size	% Passing
No. 4	100.0
No. 10	98.5

Analysis for the portion Finer than the No. 10 Sieve

Analysis Based on -3 inch fraction only

Specific Gravity: 2.75

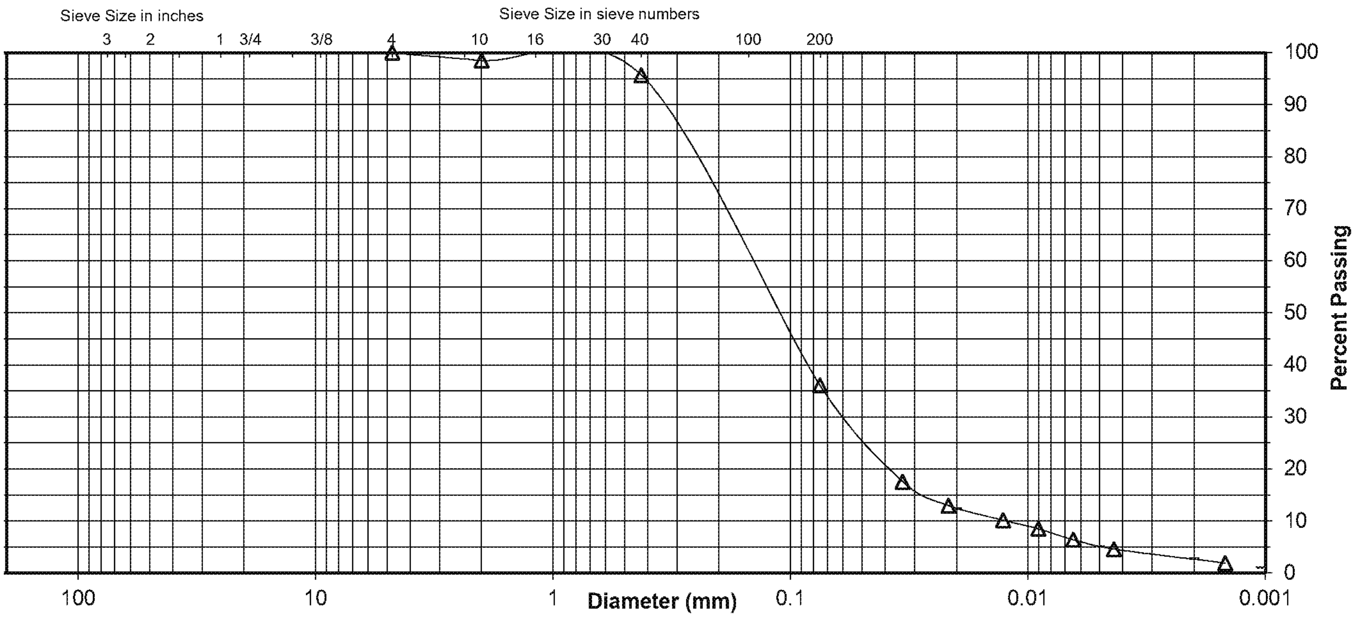
Dispersed using Apparatus A - Mechanical, for 1 minute

No. 40	95.7
No. 200	36.1
0.02 mm	12.4
0.005 mm	5.1
0.002 mm	2.8
0.001 mm	1.0

Particle Size Distribution

ASTM	Coarse Gravel	Fine Gravel	C. Sand	Medium Sand	Fine Sand	Silt	Clay
	0.0	0.0	1.5	2.8	59.6	31.0	5.1

AASHTO	Gravel	Coarse Sand	Fine Sand	Silt	Clay
	1.5	2.8	59.6	33.3	2.8



Comments ______

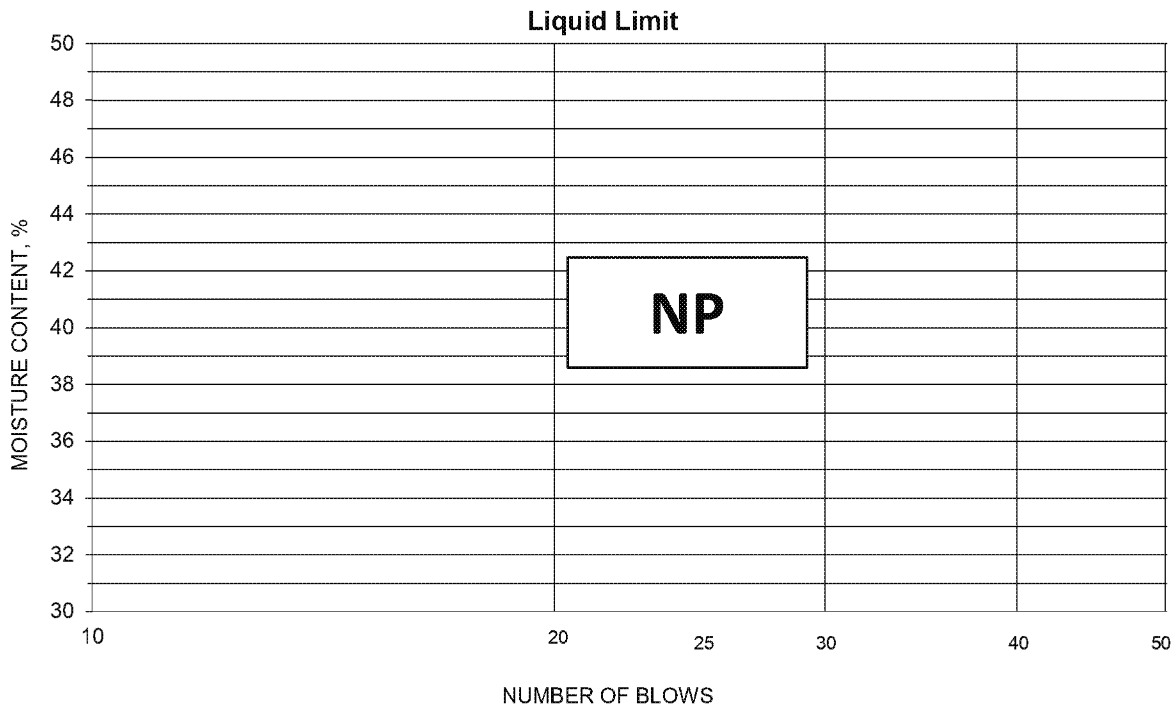
Reviewed By: RJ

Stantec

ATTERBERG LIMITS

Project	CCR Rule - AEP Clifty Creek	Project No.	175553022
Source	B-12, 60.0'-61.5'	Lab ID	13
		% + No. 40	4
Tested By	DB	Date Received	07-21-2015
Test Method	ASTM D 4318 Method A		
Test Date	07-24-2015		
Prepared	Dry		

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Number of Blows	Water Content (%)	Liquid Limit



PLASTIC LIMIT AND PLASTICITY INDEX

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Water Content (%)	Plastic Limit	Plasticity Index

Remarks:

Reviewed By RJ

Stantec

Summary of Soil Tests

Project Name	CCR Rule - AEP Clifty Creek	Project Number	175553022
Source	B-12, 70.0'-71.5'	Lab ID	15
Sample Type	SPT	Date Received	7-21-15
		Date Reported	8-3-15

Test Results

Natural Moisture Content

Test Method: ASTM D 2216

Moisture Content (%): 21.6

Particle Size Analysis

Preparation Method: ASTM D 421

Gradation Method: ASTM D 422

Hydrometer Method: ASTM D 422

Particle Size Sieve Size	Particle Size (mm)	% Passing
	N/A	
	N/A	
	N/A	
	N/A	
	N/A	
	N/A	
	N/A	
No. 10	2	100.0
No. 40	0.425	98.6
No. 200	0.075	56.5
	0.02	21.7
	0.005	3.7
	0.002	1.5
estimated	0.001	1.0

Plus 3 in. material, not included: 0 (%)

Range	ASTM (%)	AASHTO (%)
Gravel	0.0	0.0
Coarse Sand	0.0	1.4
Medium Sand	1.4	---
Fine Sand	42.1	42.1
Silt	52.8	55.0
Clay	3.7	1.5

Atterberg Limits

Test Method: ASTM D 4318 Method A

Prepared: Dry

Liquid Limit: NP

Plastic Limit: NP

Plasticity Index: NP

Activity Index: N/A

Moisture-Density Relationship

Test Not Performed

Maximum Dry Density (lb/ft^3): N/A

Maximum Dry Density (kg/m^3): N/A

Optimum Moisture Content (%): N/A

Over Size Correction %: N/A

California Bearing Ratio

Test Not Performed

Bearing Ratio (%): N/A

Compacted Dry Density (lb/ft^3): N/A

Compacted Moisture Content (%): N/A

Specific Gravity

Test Method: ASTM D 854

Prepared: Dry

Particle Size: No. 10

Specific Gravity at 20° Celsius: 2.71

Classification

Unified Group Symbol: ML

Group Name: Sandy silt

AASHTO Classification: A-4 (0)

Comments:

Reviewed By RJ

Stantec

Particle-Size Analysis of Soils
ASTM D 422

Project Name	CCR Rule - AEP Clifty Creek	Project Number	175553022
Source	B-12, 70.0'-71.5'	Lab ID	15

Sieve analysis for the Portion Coarser than the No. 10 Sieve

Test Method: ASTM D 422
Prepared using: ASTM D 421

Particle Shape: N/A
Particle Hardness: N/A

Tested By: JS
Test Date: 07-24-2015
Date Received: 07-21-2015

Maximum Particle size: No. 10 Sieve

Sieve Size	% Passing
No. 10	100.0

Analysis for the portion Finer than the No. 10 Sieve

Analysis Based on -3 inch fraction only

Specific Gravity: 2.71

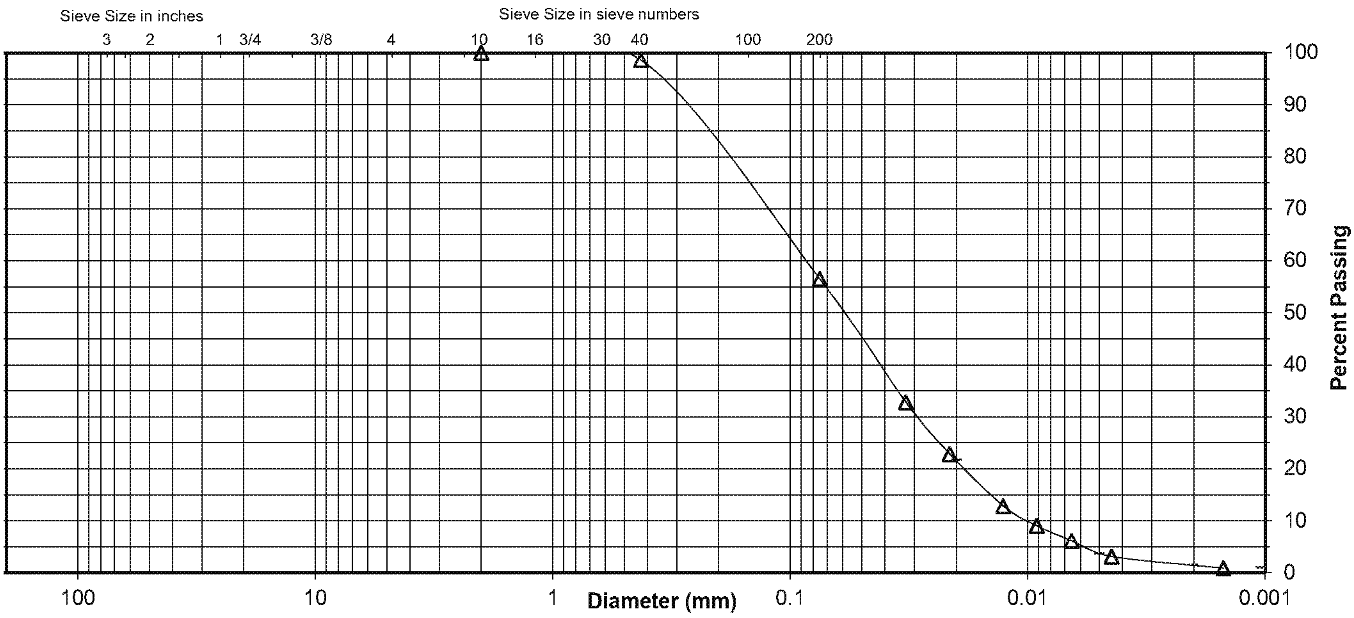
Dispersed using Apparatus A - Mechanical, for 1 minute

No. 40	98.6
No. 200	56.5
0.02 mm	21.7
0.005 mm	3.7
0.002 mm	1.5
0.001 mm	1.0

Particle Size Distribution

	Coarse Gravel	Fine Gravel	C. Sand	Medium Sand	Fine Sand	Silt	Clay
ASTM	0.0	0.0	0.0	1.4	42.1	52.8	3.7

	Gravel	Coarse Sand	Fine Sand	Silt	Clay
AASHTO	0.0	1.4	42.1	55.0	1.5



Comments ______

Reviewed By RJ

File: frm_175553022_sum_15.xlsm
Preparation Date: 1998
Revision Date: 1-2008

Stantec Consulting Services Inc.
Lexington, Kentucky

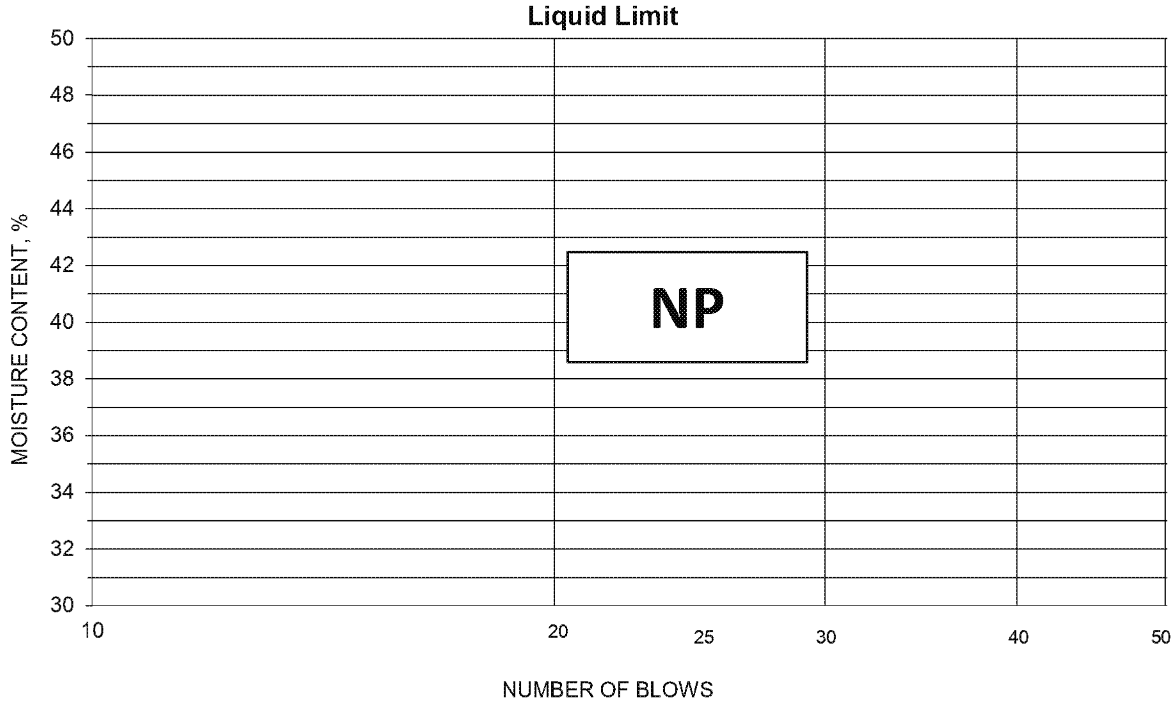
Laboratory Document
Prepared By: MW
Approved BY: TLK

Stantec

ATTERBERG LIMITS

Project	CCR Rule - AEP Clifty Creek			Project No.	175553022
Source	B-12, 70.0'-71.5'			Lab ID	15
				% + No. 40	1
Tested By	KDG	Test Method	ASTM D 4318 Method A	Date Received	07-21-2015
Test Date	07-31-2015	Prepared	Dry		

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Number of Blows	Water Content (%)	Liquid Limit



PLASTIC LIMIT AND PLASTICITY INDEX

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Water Content (%)	Plastic Limit	Plasticity Index

Remarks:

Reviewed By RJ

Stantec

Summary of Soil Tests

Project Name: CCR Rule - AEP Clifty Creek
Project Number: 175553022
Source: B-12, 80.0'-81.5'
Lab ID: 17
Sample Type: SPT
Date Received: 7-21-15
Date Reported: 8-3-15

Test Results

Natural Moisture Content

Test Method: ASTM D 2216
Moisture Content (%): 25.7

Particle Size Analysis

Preparation Method: ASTM D 421
Gradation Method: ASTM D 422
Hydrometer Method: ASTM D 422

Particle Size: Sieve Size	Particle Size: (mm)	% Passing
	N/A	
	N/A	
	N/A	
	N/A	
	N/A	
	N/A	
No. 4	4.75	100.0
No. 10	2	98.9
No. 40	0.425	98.9
No. 200	0.075	90.2
	0.02	28.8
	0.005	5.6
	0.002	1.4
estimated	0.001	0.0

Plus 3 in. material, not included: 0 (%)

Range	ASTM (%)	AASHTO (%)
Gravel	0.0	1.1
Coarse Sand	1.1	0.0
Medium Sand	0.0	---
Fine Sand	8.7	8.7
Silt	84.6	88.8
Clay	5.6	1.4

Atterberg Limits

Test Method: ASTM D 4318 Method A
Prepared: Dry
Liquid Limit: NP
Plastic Limit: NP
Plasticity Index: NP
Activity Index: N/A

Moisture-Density Relationship

Test Not Performed
Maximum Dry Density (lb/ft^3): N/A
Maximum Dry Density (kg/m^3): N/A
Optimum Moisture Content (%): N/A
Over Size Correction %: N/A

California Bearing Ratio

Test Not Performed
Bearing Ratio (%): N/A
Compacted Dry Density (lb/ft^3): N/A
Compacted Moisture Content (%): N/A

Specific Gravity

Test Method: ASTM D 854
Prepared: Dry
Particle Size: No. 10
Specific Gravity at 20° Celsius: 2.73

Classification

Unified Group Symbol: ML
Group Name: Silt
AASHTO Classification: A-4 (0)

Comments:

Reviewed By RJ

Stantec

Particle-Size Analysis of Soils
ASTM D 422

Project Name	CCR Rule - AEP Clifty Creek	Project Number	175553022
Source	B-12, 80.0'-81.5'	Lab ID	17

Sieve analysis for the Portion Coarser than the No. 10 Sieve

Test Method: ASTM D 422
Prepared using: ASTM D 421

Particle Shape: Angular
Particle Hardness: Hard and Durable

Tested By: JS
Test Date: 07-24-2015
Date Received: 07-21-2015

Maximum Particle size: No. 4 Sieve

Sieve Size	% Passing
No. 4	100.0
No. 10	98.9

Analysis for the portion Finer than the No. 10 Sieve

Analysis Based on -3 inch fraction only

Specific Gravity: 2.73

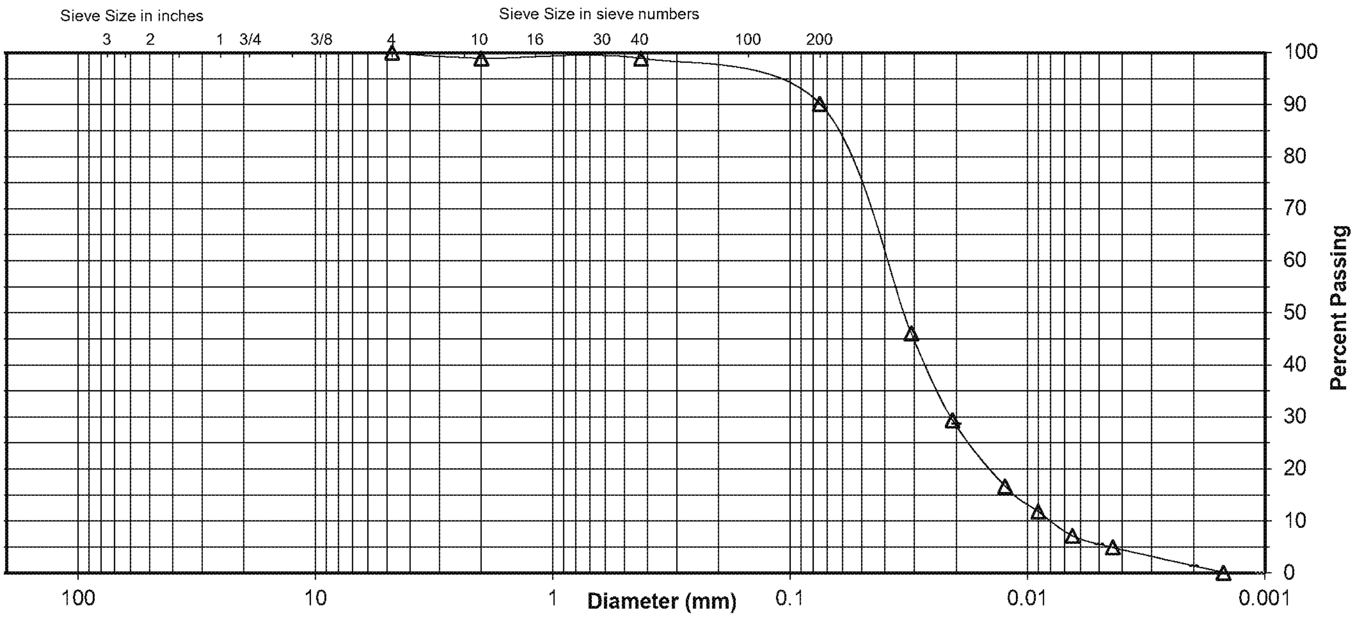
Dispersed using Apparatus A - Mechanical, for 1 minute

No. 40	98.9
No. 200	90.2
0.02 mm	28.8
0.005 mm	5.6
0.002 mm	1.4
0.001 mm	0.0

Particle Size Distribution

ASTM	Coarse Gravel	Fine Gravel	C. Sand	Medium Sand	Fine Sand	Silt	Clay
	0.0	0.0	1.1	0.0	8.7	84.6	5.6

AASHTO	Gravel	Coarse Sand	Fine Sand	Silt	Clay
	1.1	0.0	8.7	88.8	1.4



Comments ______

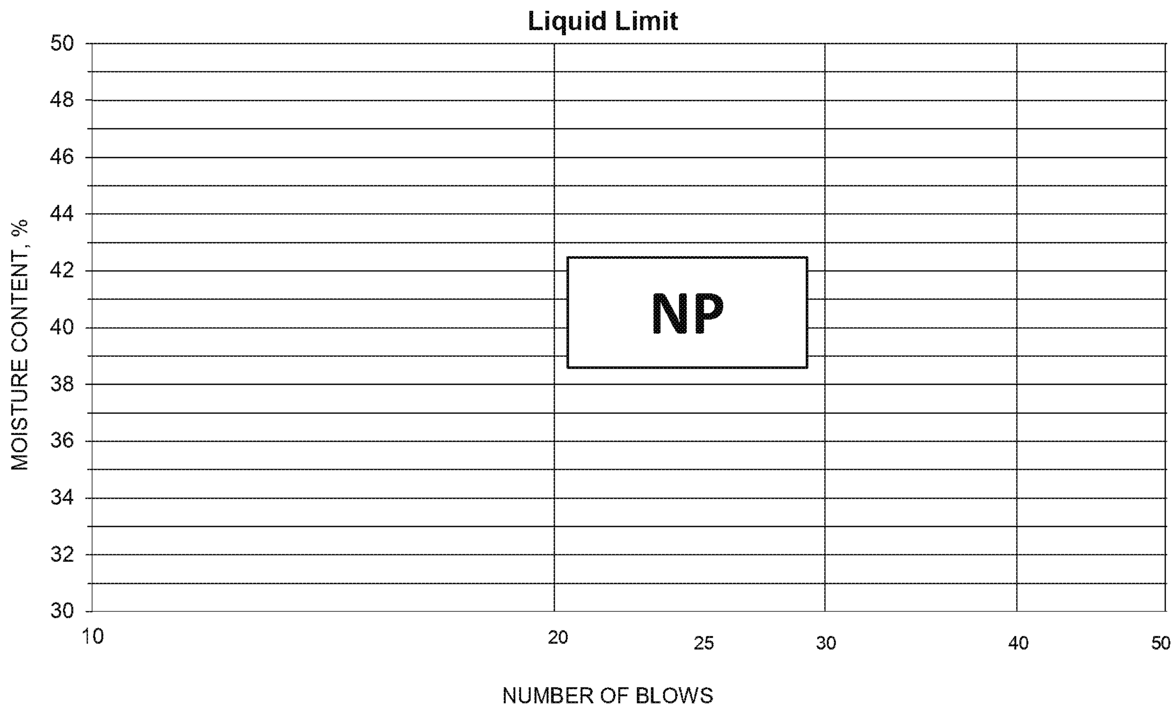
Reviewed By RJ

Stantec

ATTERBERG LIMITS

Project	CCR Rule - AEP Clifty Creek	Project No.	175553022
Source	B-12, 80.0'-81.5'	Lab ID	17
		% + No. 40	1
Tested By	KG	Test Method	ASTM D 4318 Method A
Date Received	07-21-2015		
Test Date	07-24-2015	Prepared	Dry

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Number of Blows	Water Content (%)	Liquid Limit



PLASTIC LIMIT AND PLASTICITY INDEX

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Water Content (%)	Plastic Limit	Plasticity Index

Remarks:

Reviewed By RJ

Stantec

Summary of Soil Tests

Project Name	CCR Rule - AEP Clifty Creek	Project Number	175553022
Source	B-12, 95.0'-96.5'	Lab ID	20
Sample Type	SPT	Date Received	7-21-15
		Date Reported	8-3-15

Test Results

Natural Moisture Content

Test Method: ASTM D 2216

Moisture Content (%): 23.4

Particle Size Analysis

Preparation Method: ASTM D 421

Gradation Method: ASTM D 422

Hydrometer Method: ASTM D 422

Particle Size		%
Sieve Size	(mm)	Passing
	N/A	
	N/A	
	N/A	
	N/A	
	N/A	
	N/A	
No. 4	4.75	100.0
No. 10	2	92.9
No. 40	0.425	92.4
No. 200	0.075	86.2
	0.02	71.6
	0.005	43.0
	0.002	30.6
estimated	0.001	26.0

Plus 3 in. material, not included: 0 (%)

Range	ASTM (%)	AASHTO (%)
Gravel	0.0	7.1
Coarse Sand	7.1	0.5
Medium Sand	0.5	---
Fine Sand	6.2	6.2
Silt	43.2	55.6
Clay	43.0	30.6

Atterberg Limits

Test Method: ASTM D 4318 Method A

Prepared: Dry

Liquid Limit: 42

Plastic Limit: 19

Plasticity Index: 23

Activity Index: 0.74

Moisture-Density Relationship

Test Not Performed

Maximum Dry Density (lb/ft^3): N/A

Maximum Dry Density (kg/m^3): N/A

Optimum Moisture Content (%): N/A

Over Size Correction %: N/A

California Bearing Ratio

Test Not Performed

Bearing Ratio (%): N/A

Compacted Dry Density (lb/ft^3): N/A

Compacted Moisture Content (%): N/A

Specific Gravity

Test Method: ASTM D 854

Prepared: Dry

Particle Size: No. 10

Specific Gravity at 20° Celsius: 2.68

Classification

Unified Group Symbol: CL

Group Name: Lean clay

AASHTO Classification: A-7-6 (20)

Comments:

Reviewed By RJ

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Particle-Size Analysis of Soils
ASTM D 422

Project Name	CCR Rule - AEP Clifty Creek	Project Number	175553022
Source	B-12, 95.0'-96.5'	Lab ID	20

Sieve analysis for the Portion Coarser than the No. 10 Sieve

Test Method: ASTM D 422
Prepared using: ASTM D 421

Particle Shape: Angular
Particle Hardness: Hard and Durable

Tested By: JS
Test Date: 07-24-2015
Date Received: 07-21-2015

Maximum Particle size: No. 4 Sieve

Sieve Size	% Passing
No. 4	100.0
No. 10	92.9

Analysis for the portion Finer than the No. 10 Sieve

Analysis Based on -3 inch fraction only

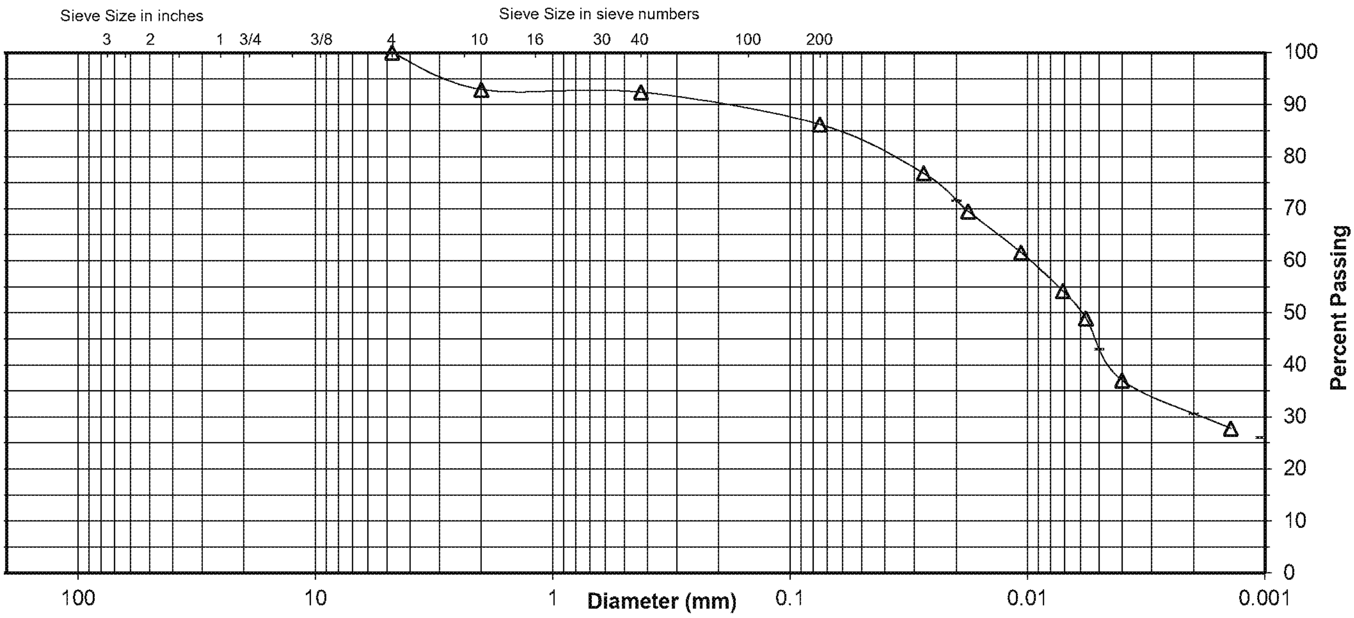
Specific Gravity 2.68

Dispersed using Apparatus A - Mechanical, for 1 minute

No. 40	92.4
No. 200	86.2
0.02 mm	71.6
0.005 mm	43.0
0.002 mm	30.6
0.001 mm	26.0

Particle Size Distribution

ASTM	Coarse Gravel	Fine Gravel	C. Sand	Medium Sand	Fine Sand	Silt	Clay
	0.0	0.0	7.1	0.5	6.2	43.2	43.0
AASHTO	Gravel			Coarse Sand	Fine Sand	Silt	Clay
	7.1			0.5	6.2	55.6	30.6



Comments

Reviewed By RJ

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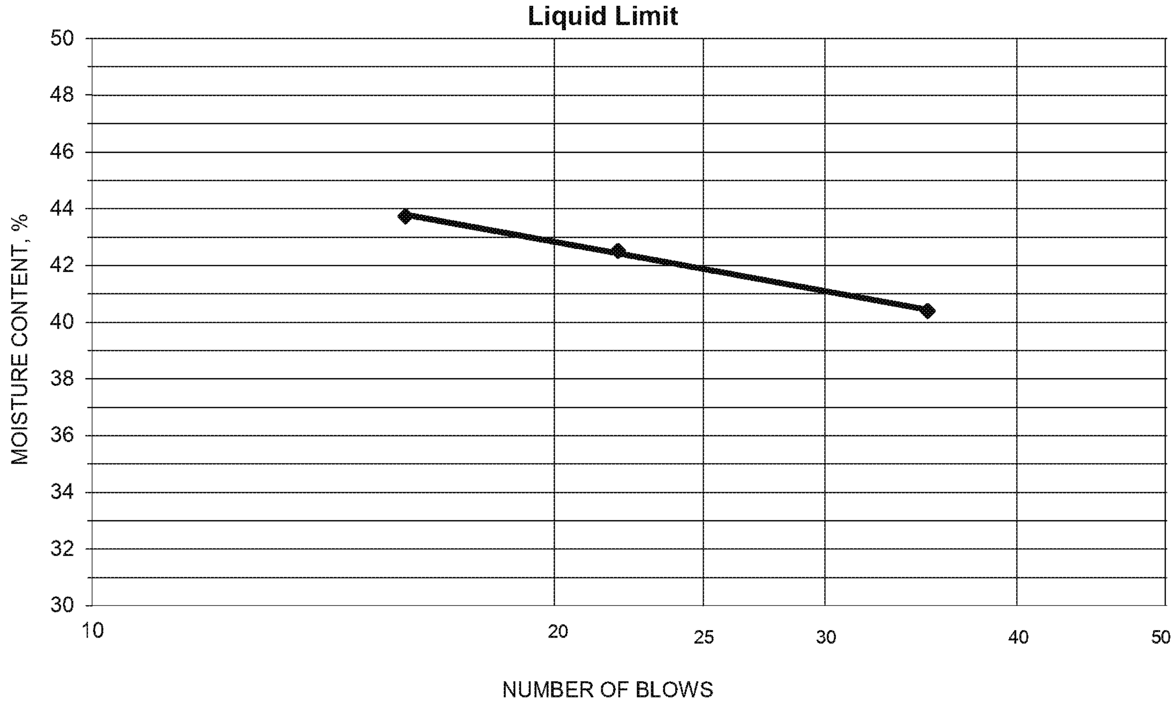
ATTERBERG LIMITS

Project	CCR Rule - AEP Clifty Creek	Project No.	175553022
Source	B-12, 95.0'-96.5'	Lab ID	20
		% + No. 40	8
Tested By	KDG Test Method ASTM D 4318 Method A	Date Received	07-21-2015
Test Date	07-31-2015 Prepared Dry		

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Number of Blows	Water Content (%)	Liquid Limit
23.24	19.63	11.14	22	42.5	42
20.15	17.36	10.98	16	43.7	
21.03	18.17	11.09	35	40.4	



PLASTIC LIMIT AND PLASTICITY INDEX

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Water Content (%)	Plastic Limit	Plasticity Index
17.59	16.51	10.80	18.9	19	23
17.15	16.14	10.89	19.2		

Remarks: ______

Reviewed By RJ

APPENDIX E

CONSOLIDATED-UNDRAINED TRIAXIAL TESTS

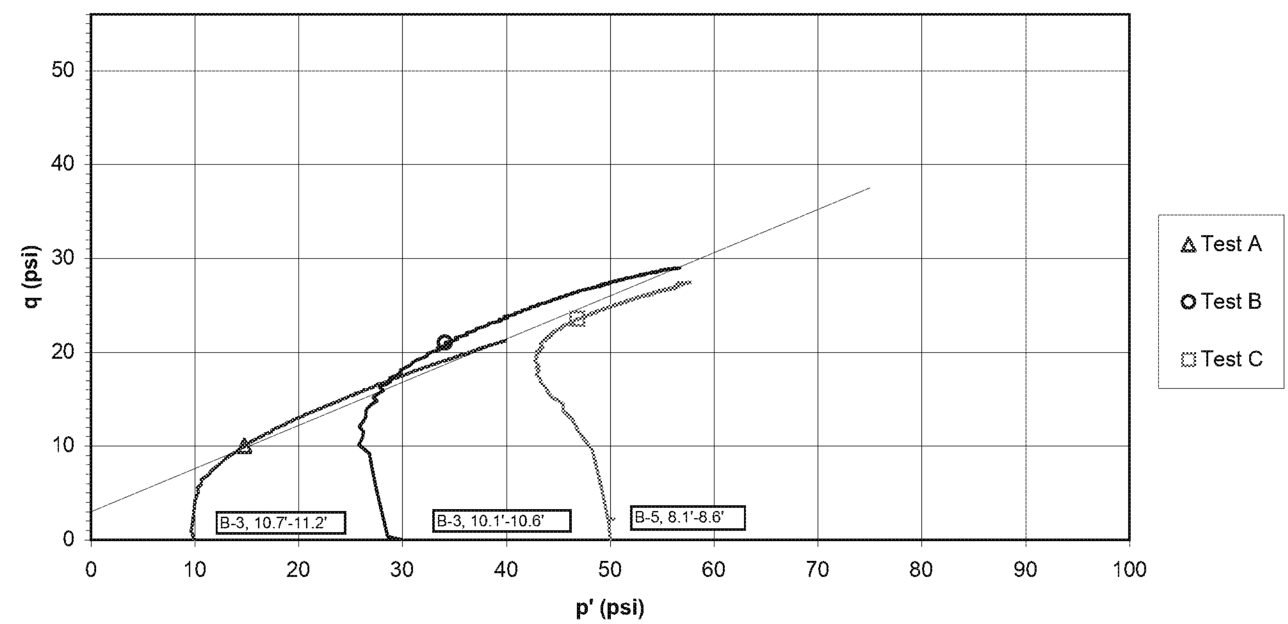
BOILER SLAG POND DAM

Stantec

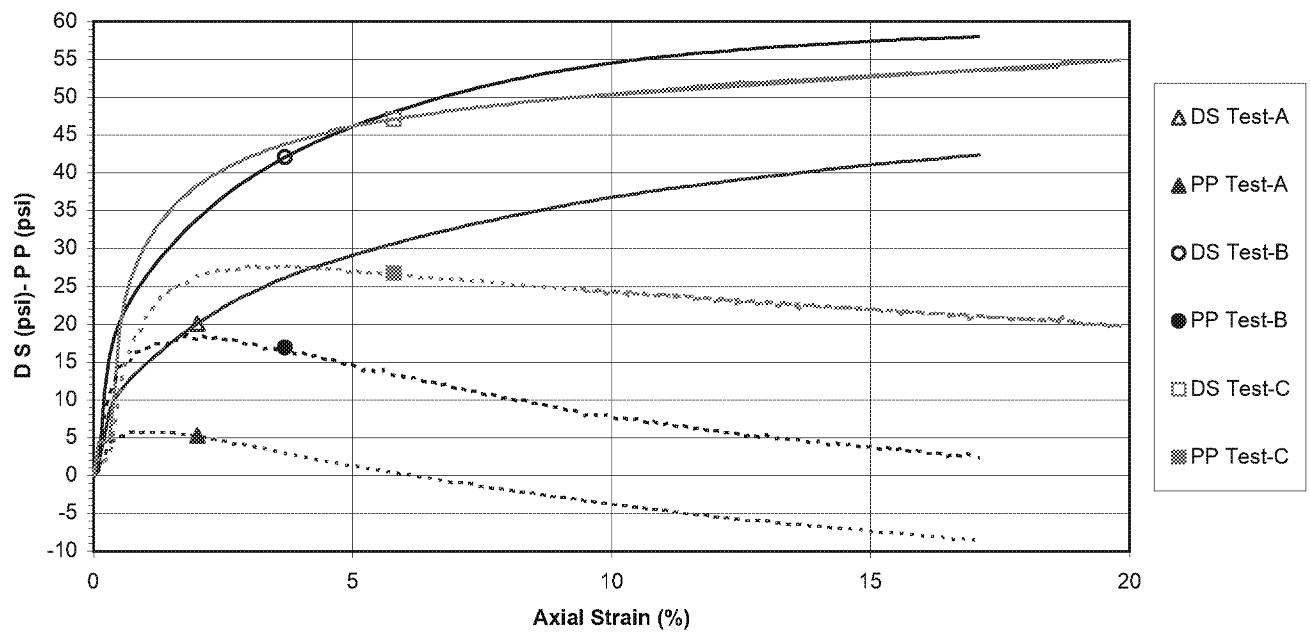
Consolidated Undrained Triaxial Test
ASTM D4767-04

Project	AEP-Clifty Creek-West Bottom and Fly Ash Ponds subsurface exploration	Project No.	175539022
Sample ID	B-3, 10.7'-11.2' & B-3, 10.1'-10.6' & B-5, 8.1'-8.6'	Test Number	1
	ϕ' = 27.4 deg.	c' =	490 psf
	Failure Criterion: Maximum Effective Principal Stress Ratio		

p' vs. q Plot



Deviator Stress and Induced Pore Pressure vs. Axial Strain

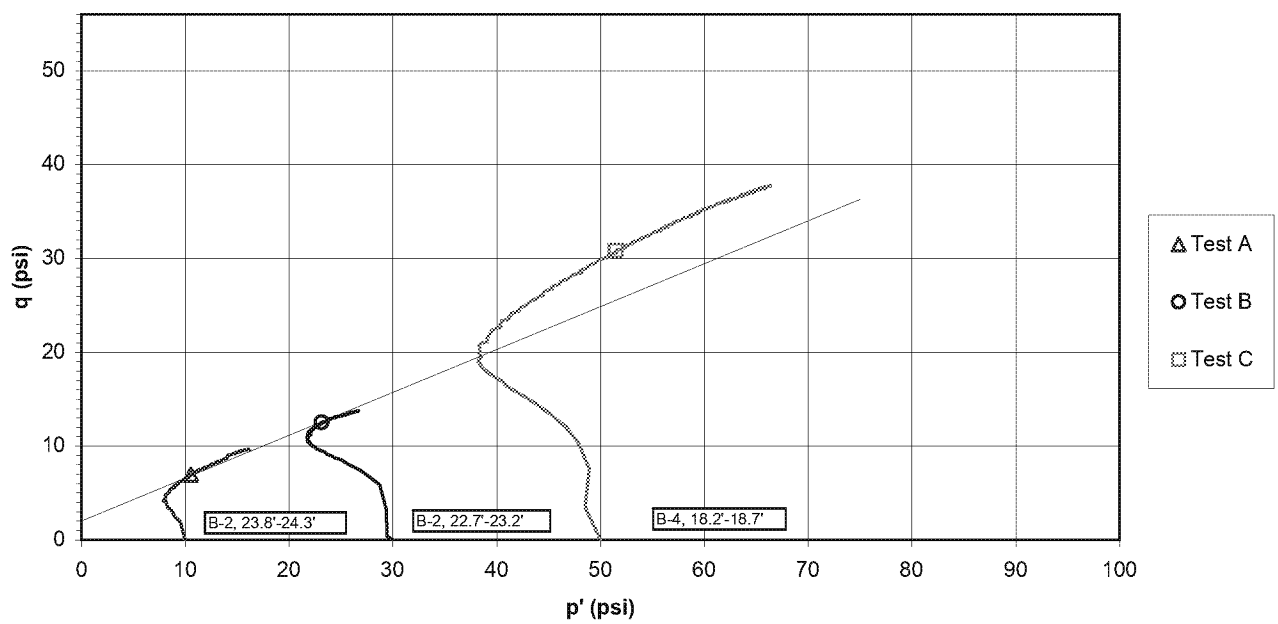


Stantec

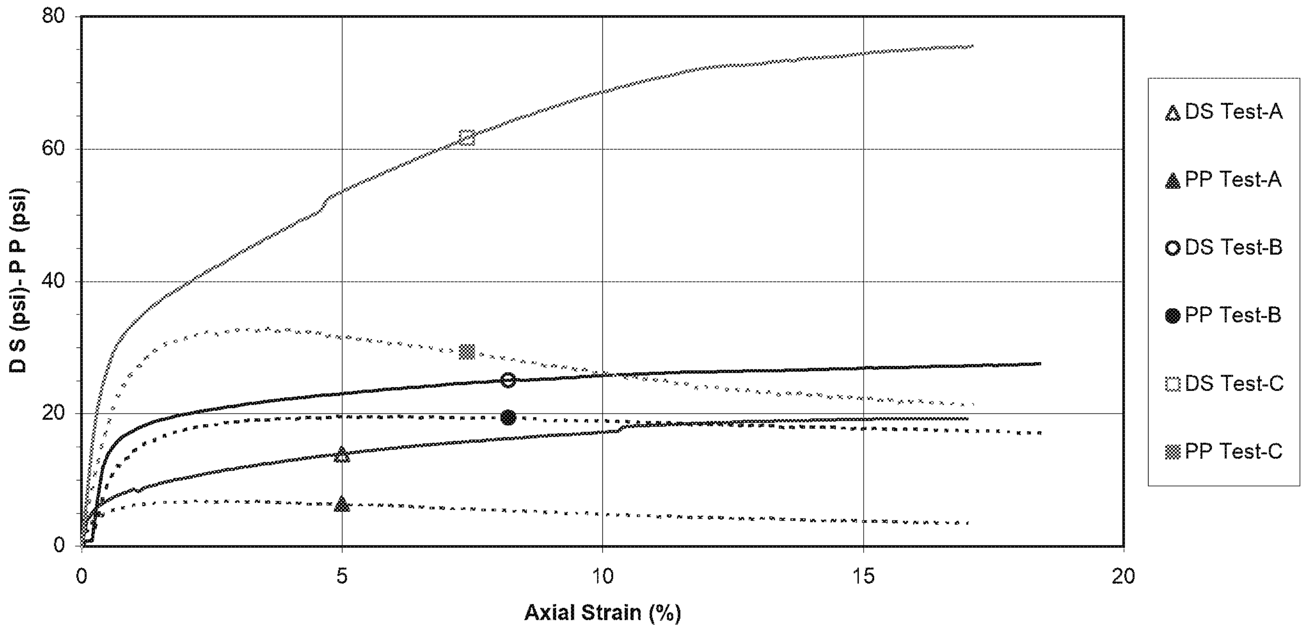
Consolidated Undrained Triaxial Test
ASTM D4767-04

Project	AEP-Clifty Creek-West Bottom Ash and Fly Ash Ponds subsurface exploration	Project No.	175539022
Sample ID	B-2, 23.8'-24.3' & B-2, 22.7'-23.2' & B-4, 18.2'-18.7'	Test Number	2
	ϕ' = 27.2 deg.	c' =	320 psf
	Failure Criterion: Maximum Effective Principal Stress Ratio		

p' vs. q Plot



Deviator Stress and Induced Pore Pressure vs. Axial Strain

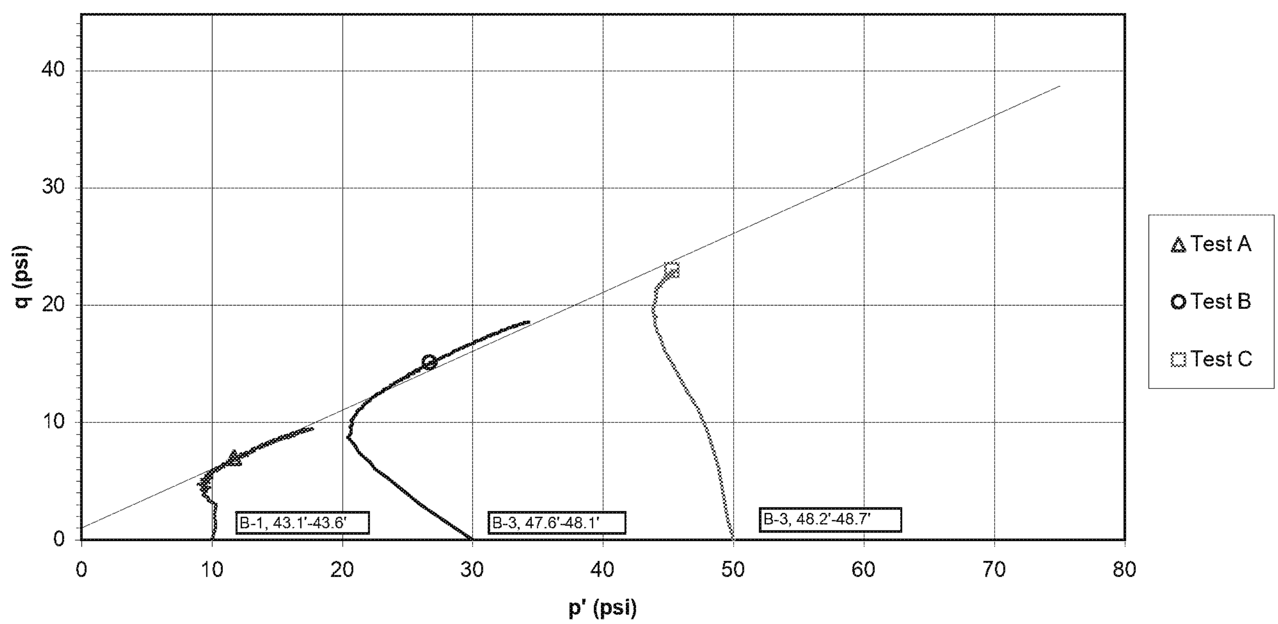


Stantec

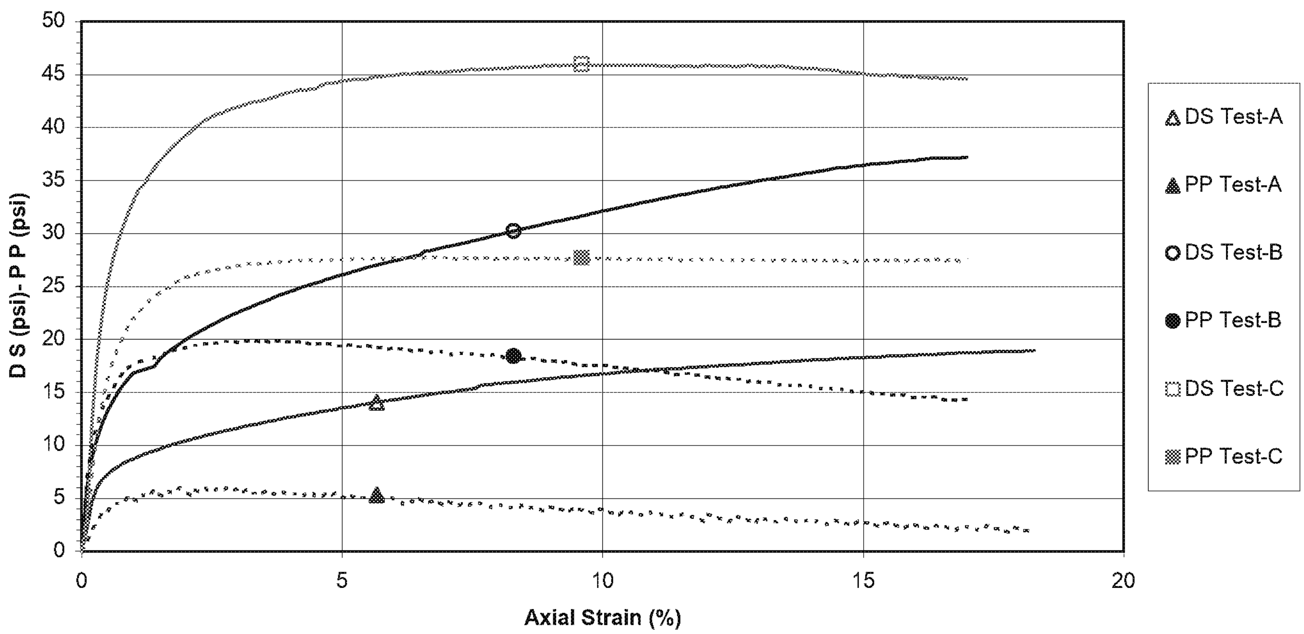
Consolidated Undrained Triaxial Test
ASTM D4767-04

Project	AEP-Clifty Creek-West Bottom Ash and Fly Ash Ponds subsurface exploration	Project No.	175539022
Sample ID	B-1, 43.1'-43.6' & B-3, 47.6'-48.1' & B-3, 48.2'-48.7'	Test Number	3
	ϕ' = 30.2 deg.	c' =	170 psf
	Failure Criterion: Maximum Effective Principal Stress Ratio		

p' vs. q Plot



Deviator Stress and Induced Pore Pressure vs. Axial Strain



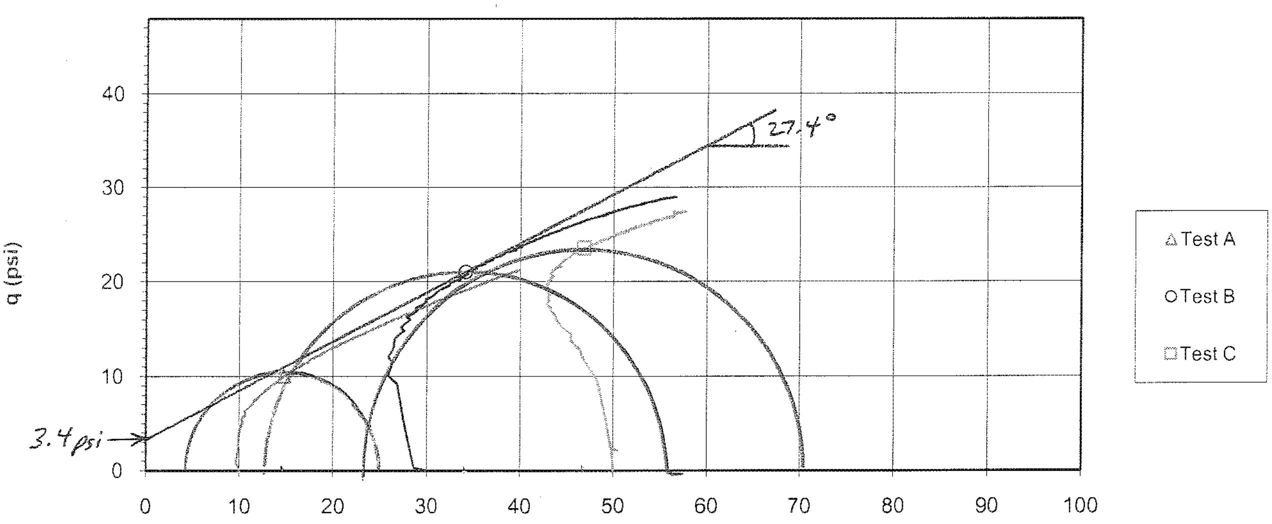
Stantec

Consolidated Undrained Triaxial Test
ASTM D4767-04

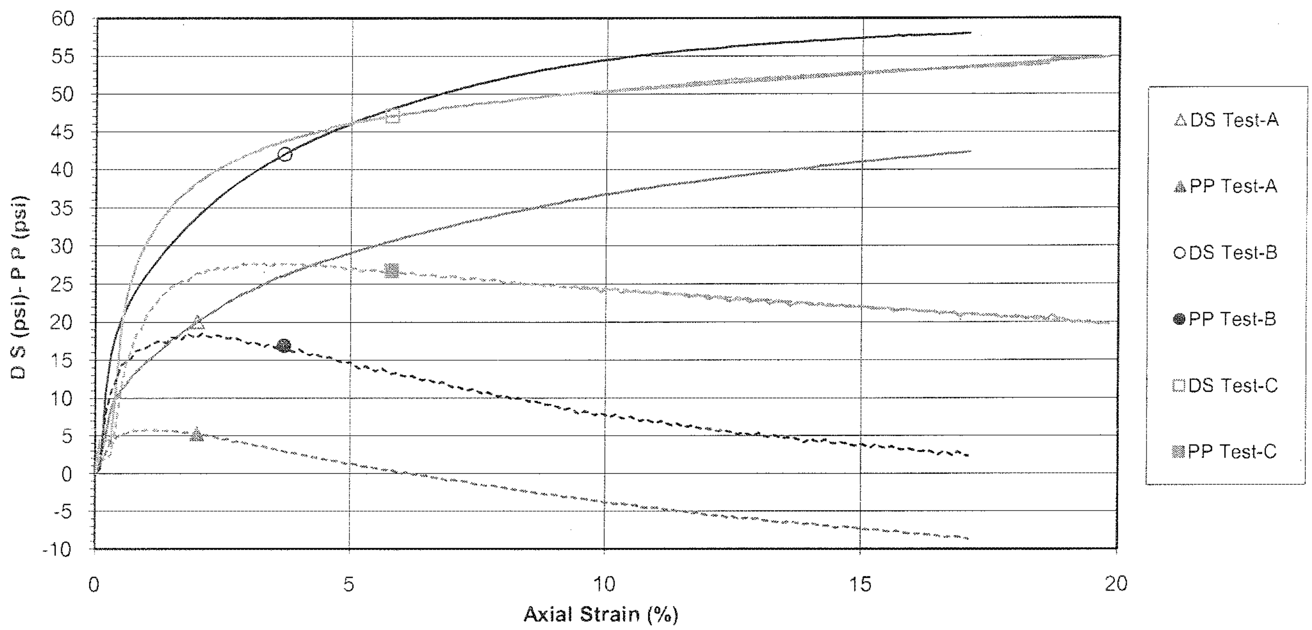
Project	AEP-Clifty Creek-West Bottom and Fly Ash Ponds subsurface exploration	Project No.	175539022
Sample ID	B-3, 10.7'-11.2' & B-3, 10.1'-10.6' & B-5, 8.1'-8.6'	Test Number	1
	ϕ' = 27.4 deg.	c' =	490 psf

Failure Criterion: Maximum Effective Principal Stress Ratio

p' vs. q Plot



Deviator Stress and Induced Pore Pressure vs. Axial Strain



Consolidated Undrained Triaxial Test
ASTM D4767-04

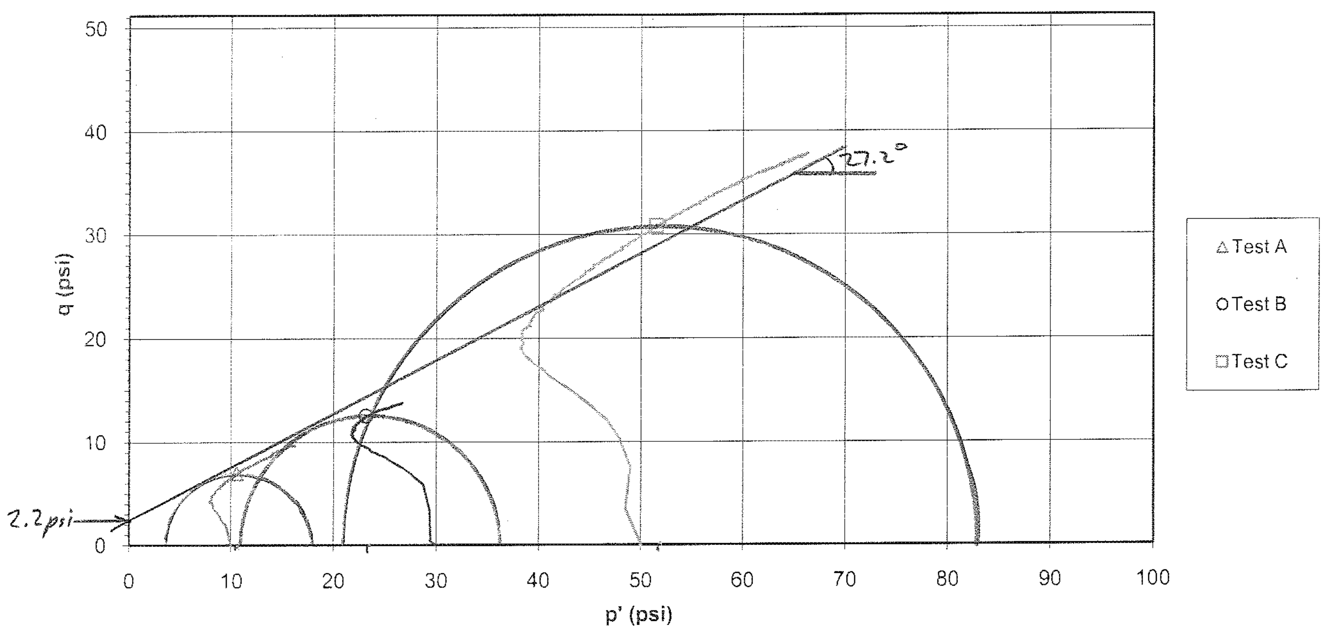
Project: AEP-Clifty Creek-West Bottom Ash and Fly Ash Ponds subsurface exploration
Sample ID: B-2, 23.8'-24.3' & B-2, 22.7'-23.2' & B-4, 18.2'-18.7'

Project No. 175539022
Test Number 2

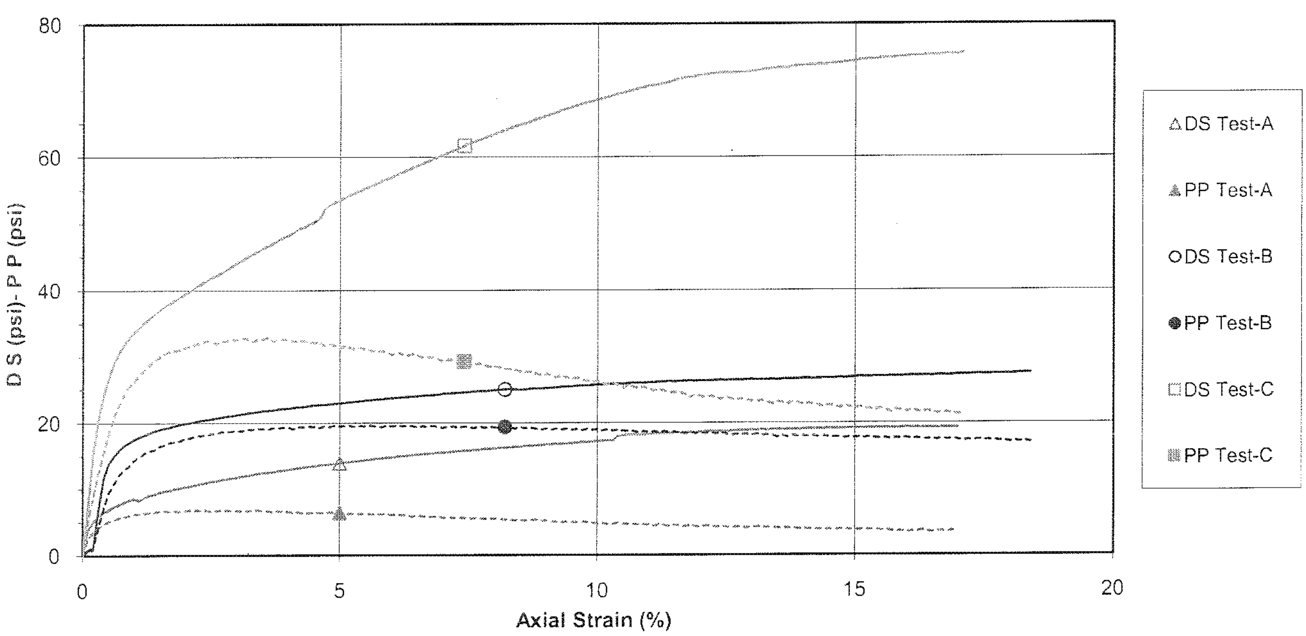
ϕ' = 27.2 deg.   c' = 320 psf

Failure Criterion: Maximum Effective Principal Stress Ratio

p' vs. q Plot



Deviator Stress and Induced Pore Pressure vs. Axial Strain



File: 175539022_CU-2emk.xls Sheet: Plots
Preparation Date: 11-1998
Revision Date: 1-2008

Stantec Consulting Services Inc.

Laboratory Document
Prepared By: JW
Approved By: TLK

Stantec

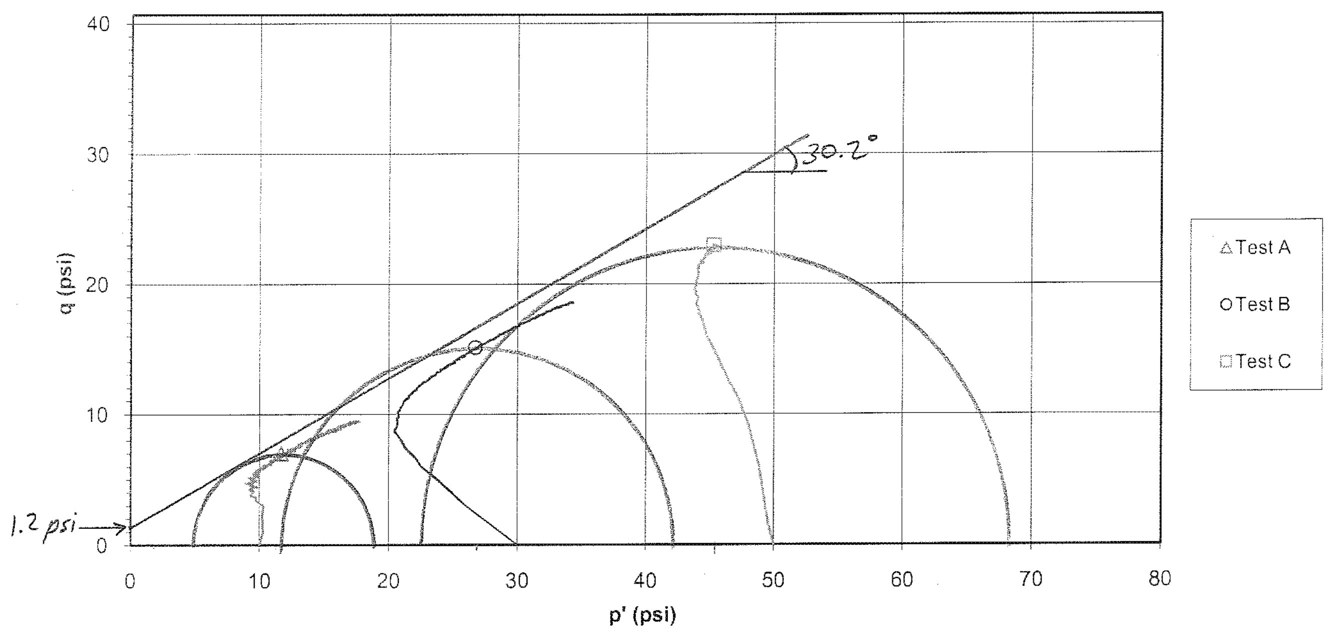
Consolidated Undrained Triaxial Test
ASTM D4767-04

Project	AEP-Clifty Creek-West Bottom Ash and Fly Ash Ponds subsurface exploration	Project No.	175539022
Sample ID	B-1, 43.1'-43.6' & B-3, 47.6'-48.1' & B-3, 48.2'-48.7'	Test Number	3

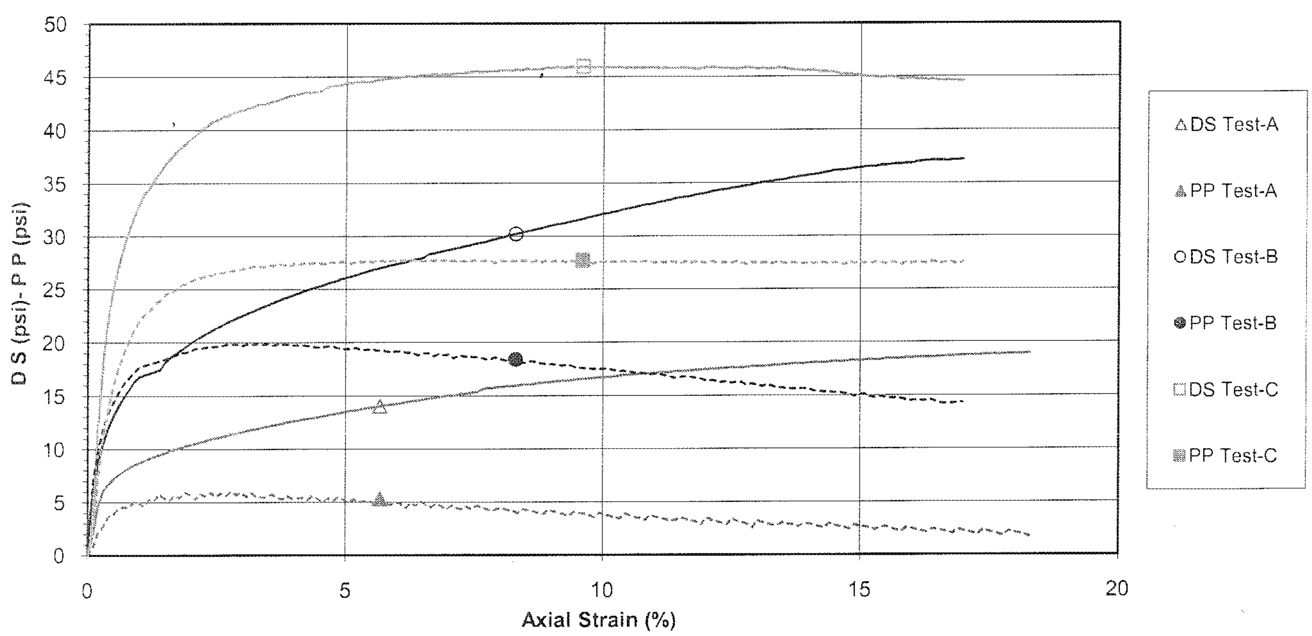
ϕ' = 30.2 deg. c' = 170 psf

Failure Criterion: Maximum Effective Principal Stress Ratio

p' vs. q Plot

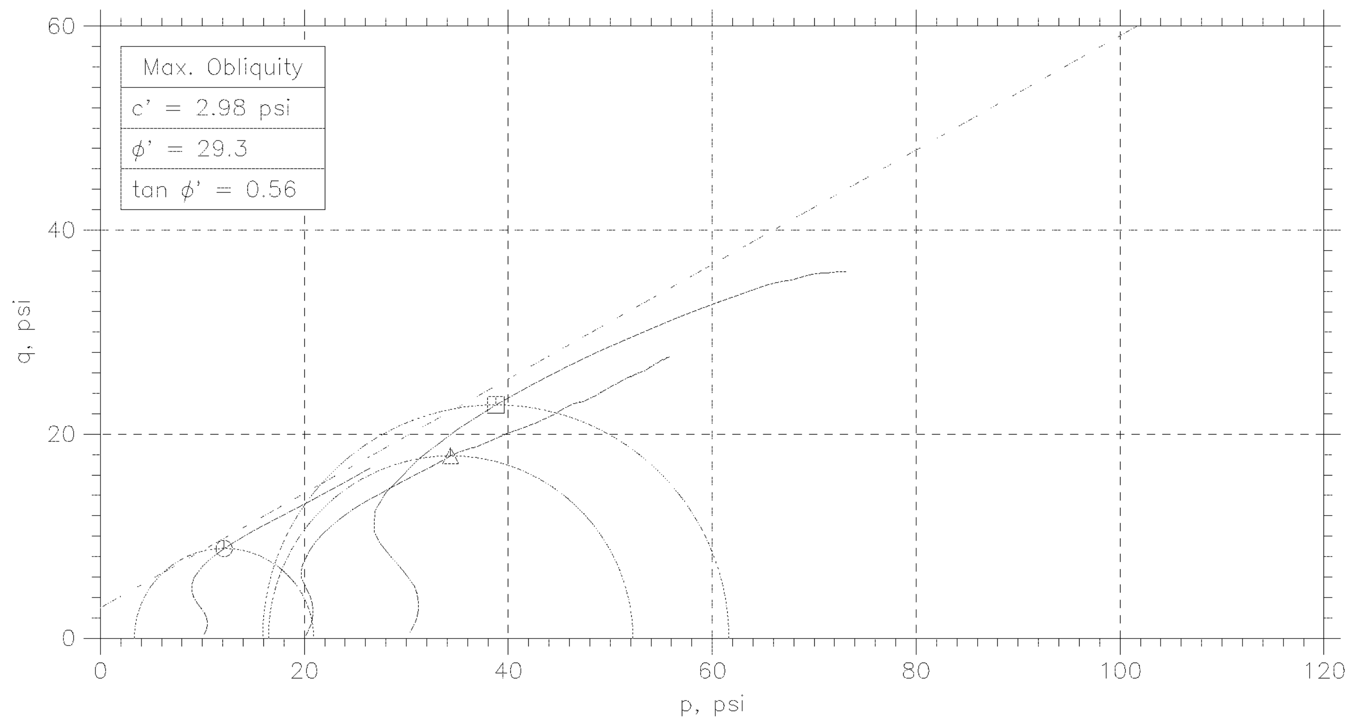


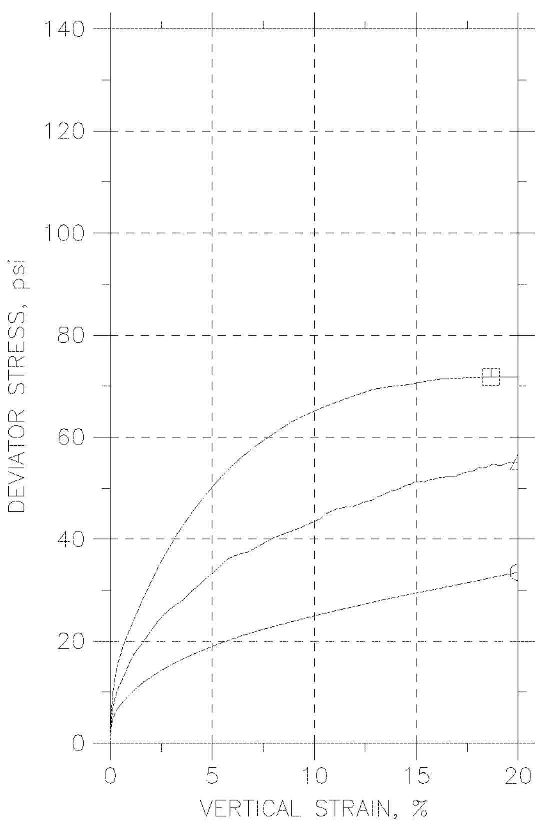
Deviator Stress and Induced Pore Pressure vs. Axial Strain



LANDFILL RUNOFF COLLECTION POND

CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767





	Symbol	○	△	□	
	Sample No.	---	---	---	
	Test No.	1.1	1.2	1.3	
	Depth	25.8-26.0	26.4-27.0	28.4-29.0	
Initial	Diameter, in	2.835	2.834	2.832	
	Height, in	6.314	5.928	5.929	
	Water Content, %	20.2	21.0	19.0	
	Dry Density, pcf	109.	107.5	111.3	
	Saturation, %	99.8	99.6	99.7	
	Void Ratio	0.546	0.568	0.515	
Before Shear	Water Content, %	21.0	21.6	19.1	
	Dry Density, pcf	107.7	106.5	111.2	
	Saturation*, %	100.0	100.0	100.0	
	Void Ratio	0.566	0.583	0.515	
	Back Press., psi	137.2	125.1	116.2	
	Ver. Eff. Cons. Stress, psi	9.834	19.88	29.8	
	Shear Strength, psi	16.74	27.57	35.9	
	Strain at Failure, %	20	20	18.7	
	Strain Rate, %/min	0.08	0.08	0.08	
	B-Value	0.96	0.95	0.95	
	Estimated Specific Gravity	2.7	2.7	2.7	
	Liquid Limit	---	---	---	
	Plastic Limit	---	---	---	

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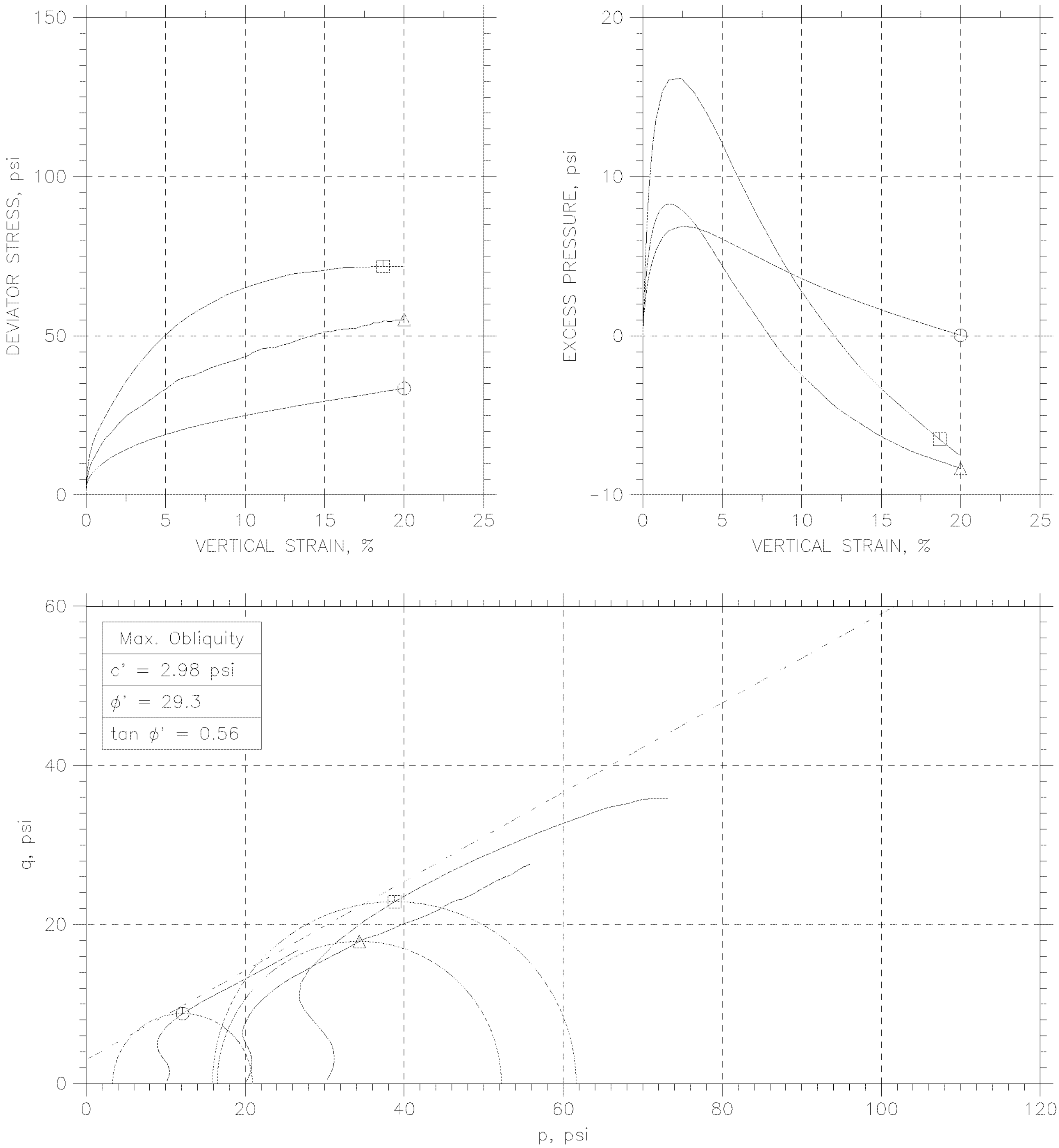
Project: Clifty Creek
Location: Jefferson, IN
Project No.: GTX-1516
Boring No.: B-7
Sample Type: UD
Description: Light Brown
Remarks: System 1062

Mon, 18-JAN-2010 16:57:15

CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767



	Sample No.	Test No.	Depth	Tested By	Test Date	Checked By	Check Date	Test File
○	---	1.1	25.8-26.0	jm	12/10/09	mm		1516-1.1.dat
△	---	1.2	26.4-27.0	jm	12/10/09	mm		1516-1.2.dat
□	---	1.3	28.4-29.0	jm	12/9/09	mm		1516-1.3.dat

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Project: Clifty Creek	Location: Jefferson, IN	Project No.: GTX-1516
Boring No.: B-7	Sample Type: UD	
Description: Light Brown		
Remarks: System 1062		

Mon, 18-JAN-2010 16:57:17

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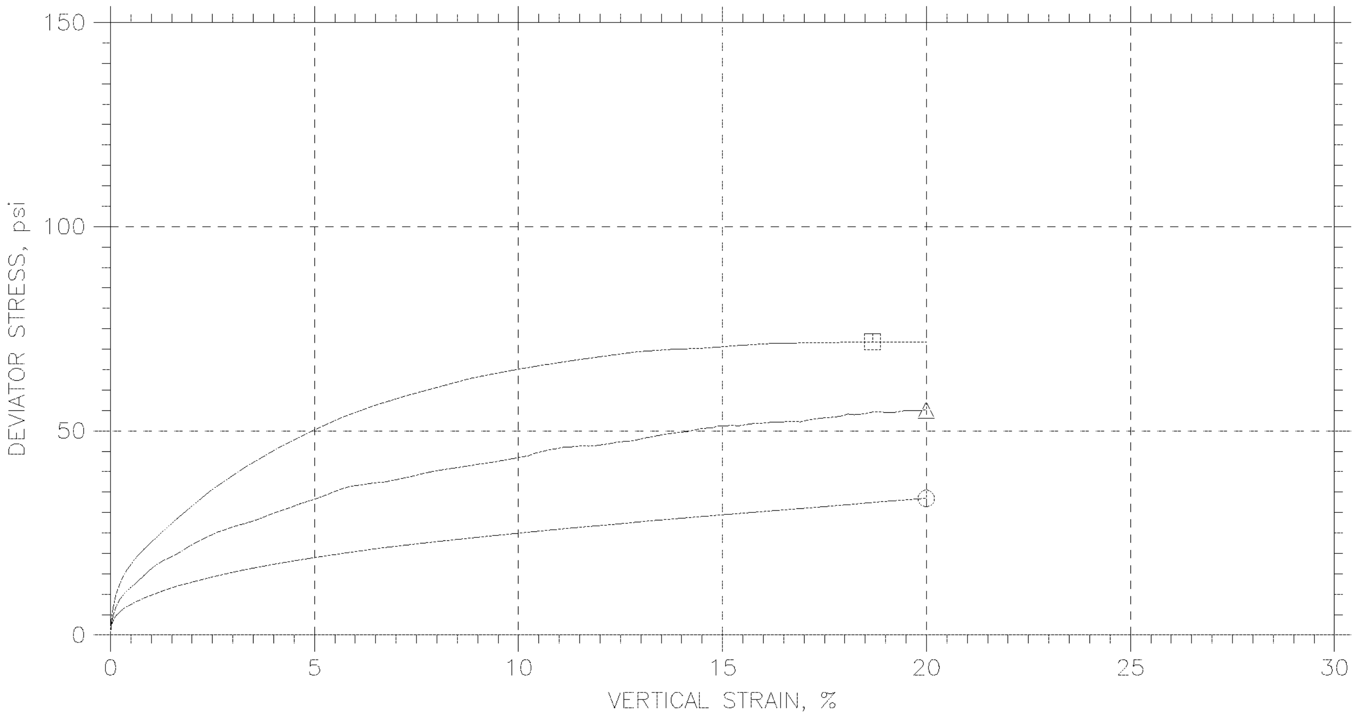

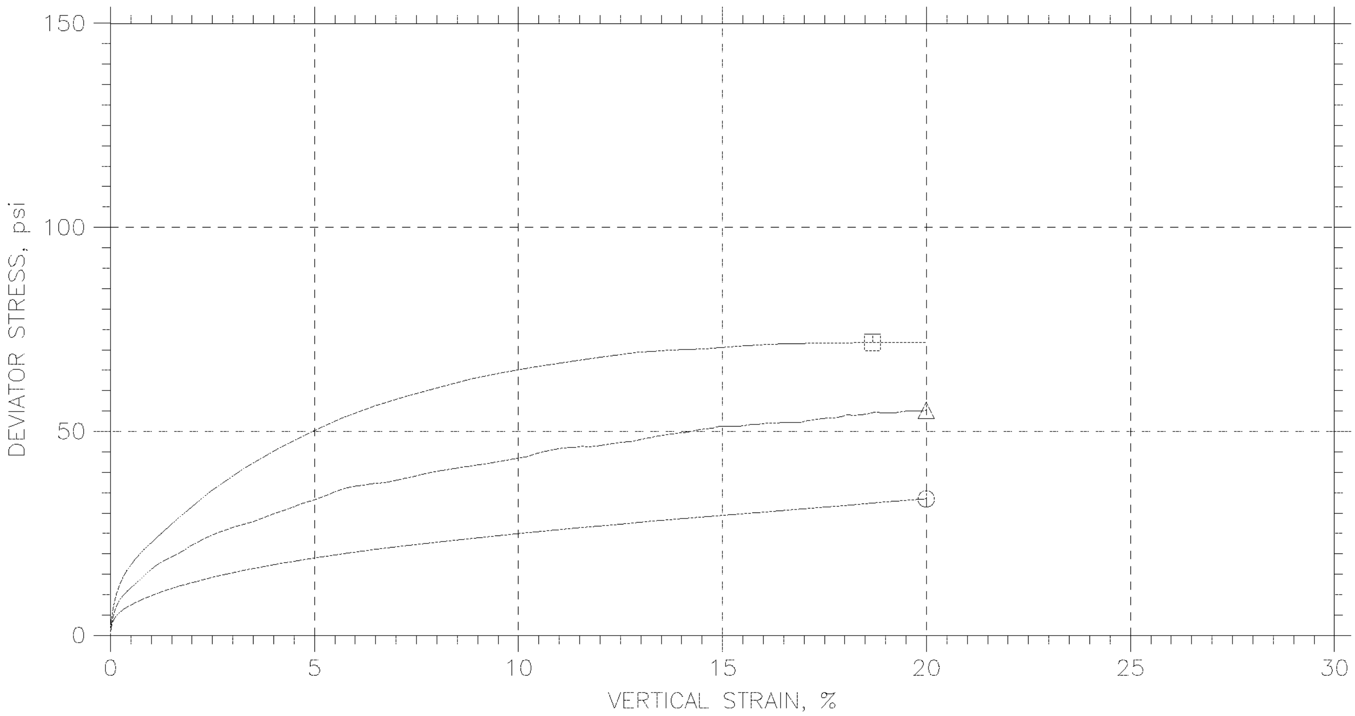

	Sample No.	Test No.	Depth	Tested By	Test Date	Checked By	Check Date	Test File
○	---	1.1	25.8-26.0	jm	12/10/09	mm		1516-1.1.dat
△	---	1.2	26.4-27.0	jm	12/10/09	mm		1516-1.2.dat
□	---	1.3	28.4-29.0	jm	12/9/09	mm		1516-1.3.dat

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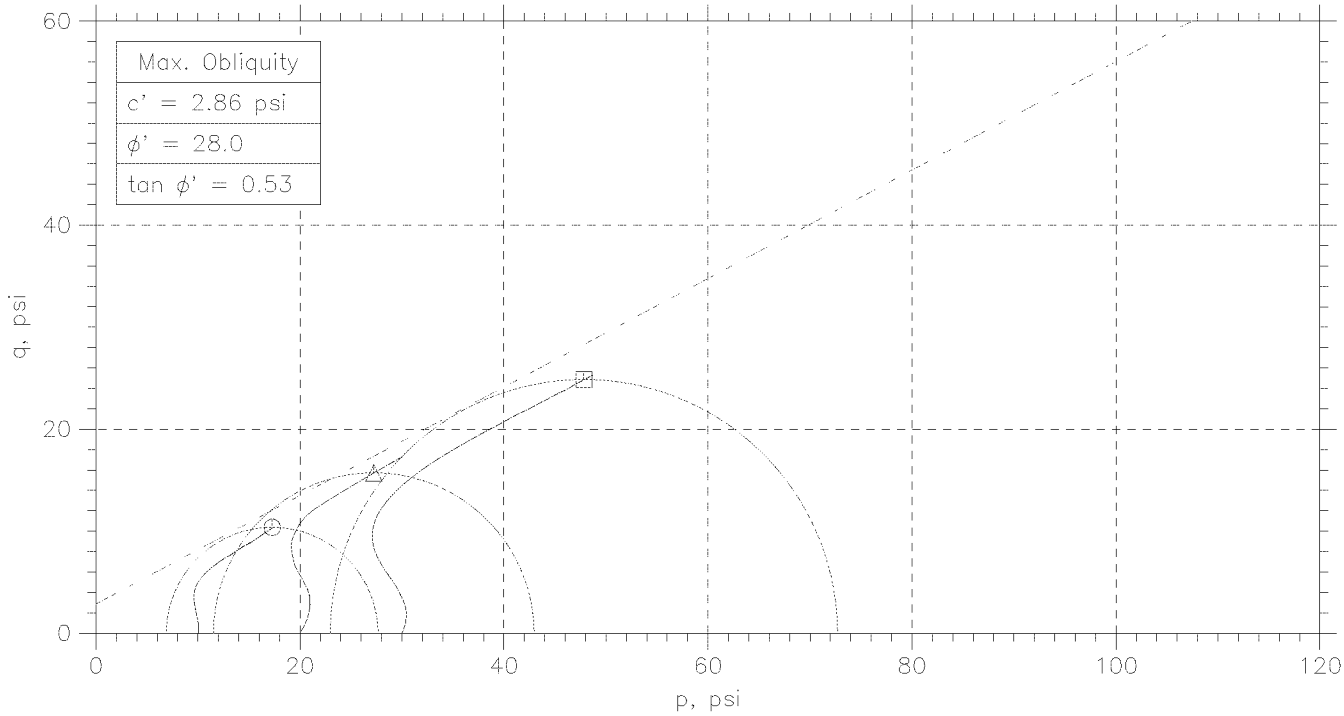
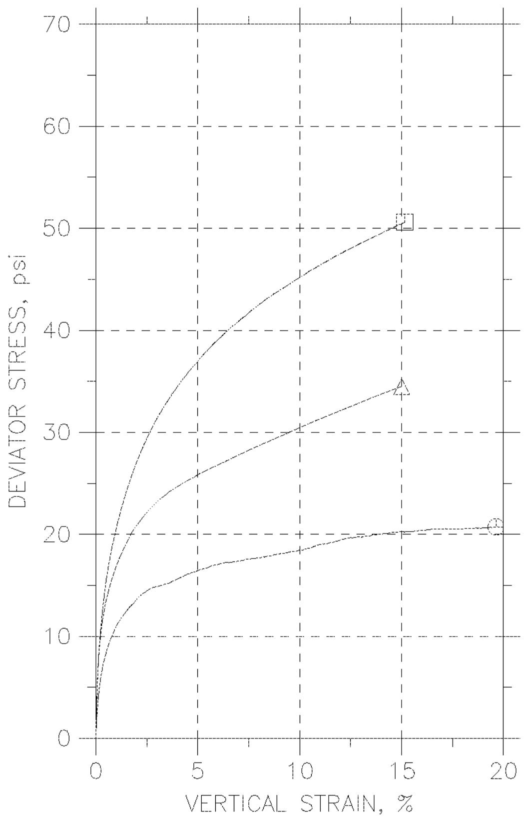
Project: Clifty Creek	Location: Jefferson, IN	Project No.: GTX-1516
Boring No.: B-7	Sample Type: UD	
Description: Light Brown		
Remarks: System 1062		

Mon, 18-JAN-2010 16:57:18

CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767





	Symbol	○	△	□	
	Sample No.	---	---	---	
	Test No.	2.1	2.2	2.3	
	Depth	25.8-26.4	28.4-29.0	30.3-30.9'	
Initial	Diameter, in	2.82	2.824	2.838	
Initial	Height, in	5.82	6.027	6.001	
Initial	Water Content, %	21.0	20.7	20.9	
Initial	Dry Density, pcf	107.2	107.6	107.6	
Initial	Saturation, %	99.2	98.7	99.6	
Initial	Void Ratio	0.572	0.567	0.567	
Before Shear	Water Content, %	20.5	19.8	19.0	
Before Shear	Dry Density, pcf	108.5	109.8	111.4	
Before Shear	Saturation*, %	100.0	100.0	100.0	
Before Shear	Void Ratio	0.554	0.535	0.513	
Before Shear	Back Press., psi	59.25	124.8	56.31	
	Ver. Eff. Cons. Stress, psi	9.968	19.98	29.96	
	Shear Strength, psi	10.37	17.25	25.3	
	Strain at Failure, %	19.6	15	15.2	
	Strain Rate, %/min	0.016	0.016	0.016	
	B-Value	0.95	0.96	0.95	
	Estimated Specific Gravity	2.7	2.7	2.7	
	Liquid Limit	---	---	---	
	Plastic Limit	---	---	---	

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Project: Clifty Creek	
Location: Jefferson, IN.	
Project No.: GTX-1516	
Boring No.: B-8	
Sample Type: UD	
Description: Greenish brown lean clay with sand	
Remarks: 2054	

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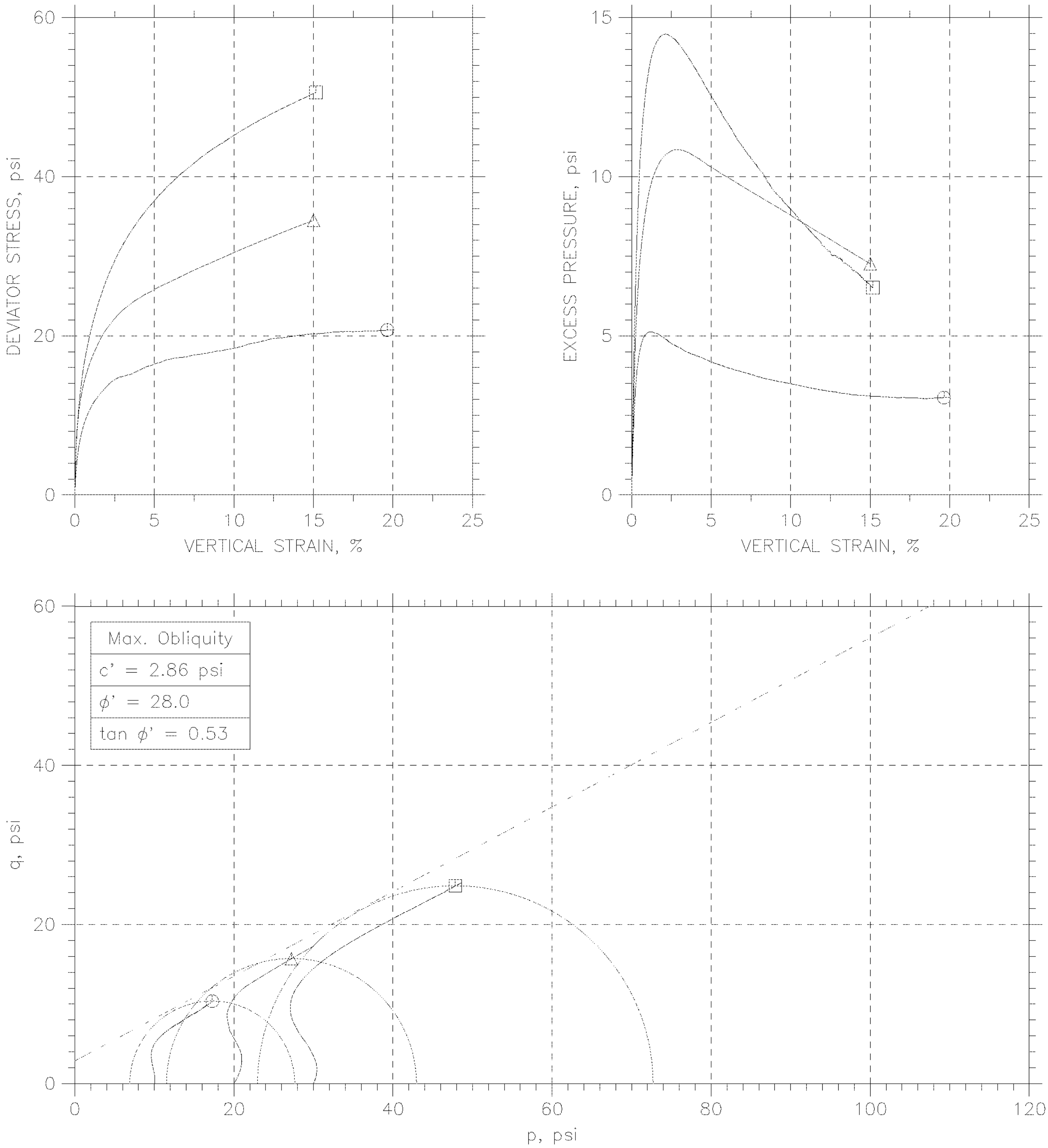
CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767



	Sample No.	Test No.	Depth	Tested By	Test Date	Checked By	Check Date	Test File
○	---	2.1	25.8-26.4	jm	12/11/09	mm		1516-2.1.dat
△	---	2.2	28.4-29.0	jm	12/11/09	mm		1516-2.2A.dat
□	---	2.3	30.3-30.9'	jm	12/09/09	mm		1516-2.3.dat

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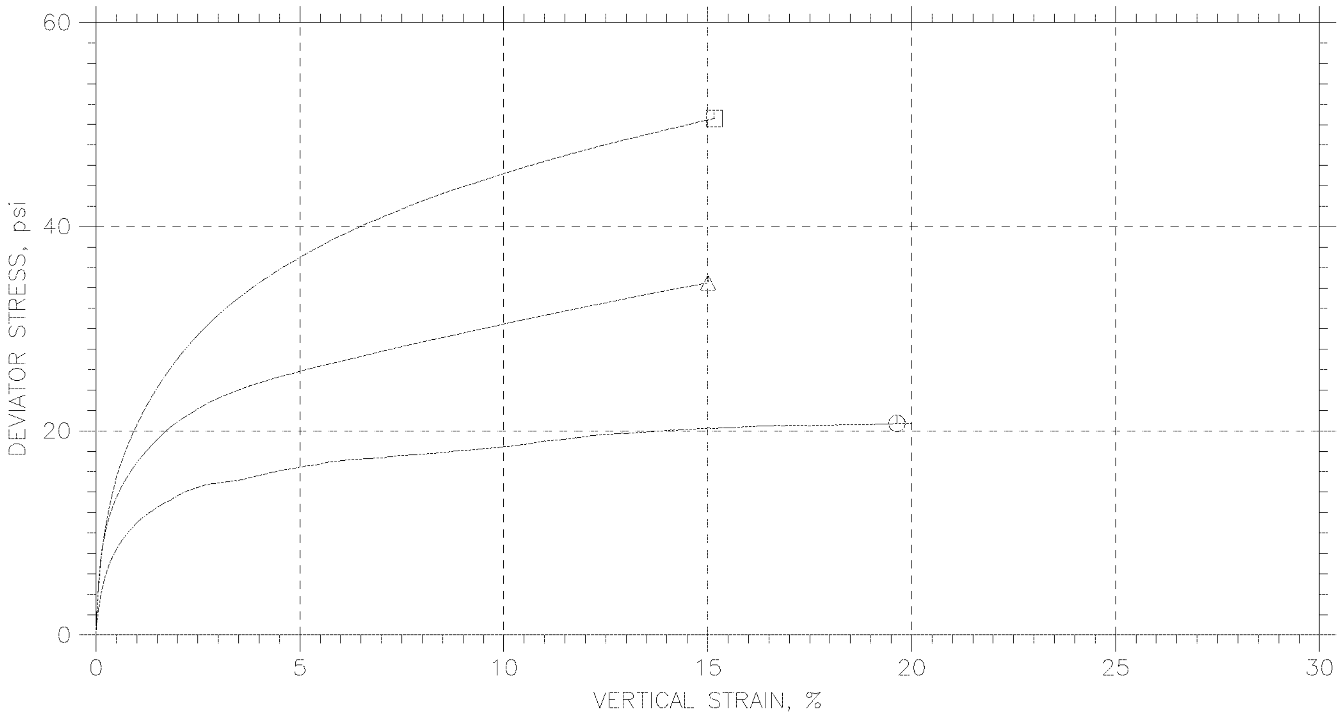
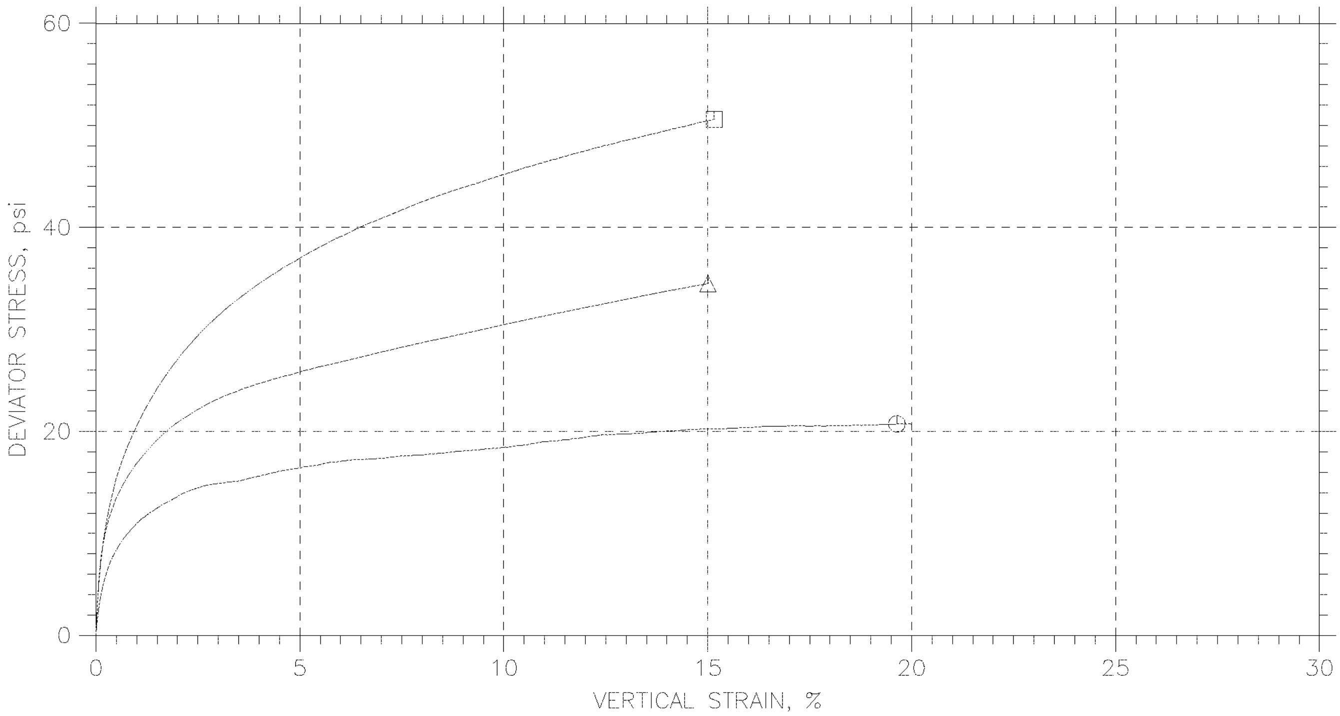
Project: Clifty Creek	Location: Jefferson, IN.	Project No.: GTX-1516
Boring No.: B-8	Sample Type: UD	
Description: Greenish brown lean clay with sand		
Remarks: 2054		

Tue, 19-JAN-2010 09:45:53

CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767





	Sample No.	Test No.	Depth	Tested By	Test Date	Checked By	Check Date	Test File
⦶	---	2.1	25.8-26.4	jm	12/11/09	mm		1516-2.1.dat
△	---	2.2	28.4-29.0	jm	12/11/09	mm		1516-2.2A.dat
◫	---	2.3	30.3-30.9'	jm	12/09/09	mm		1516-2.3.dat

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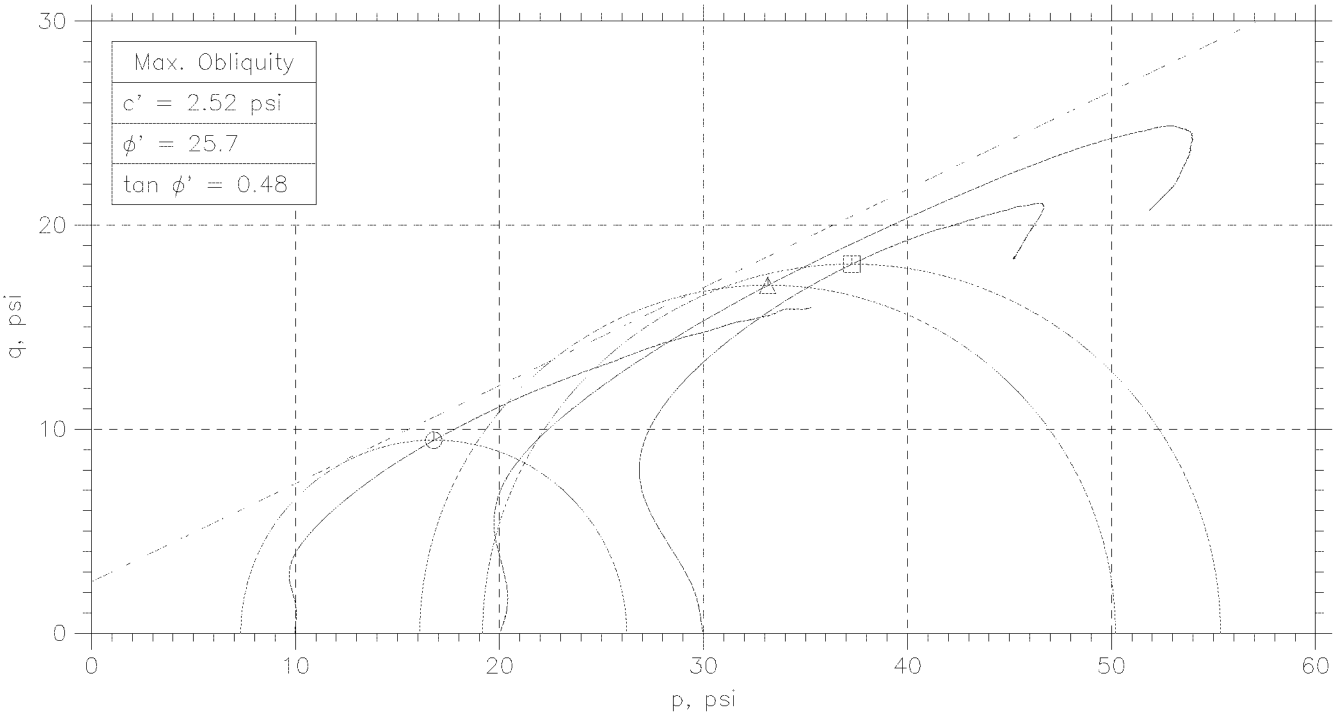
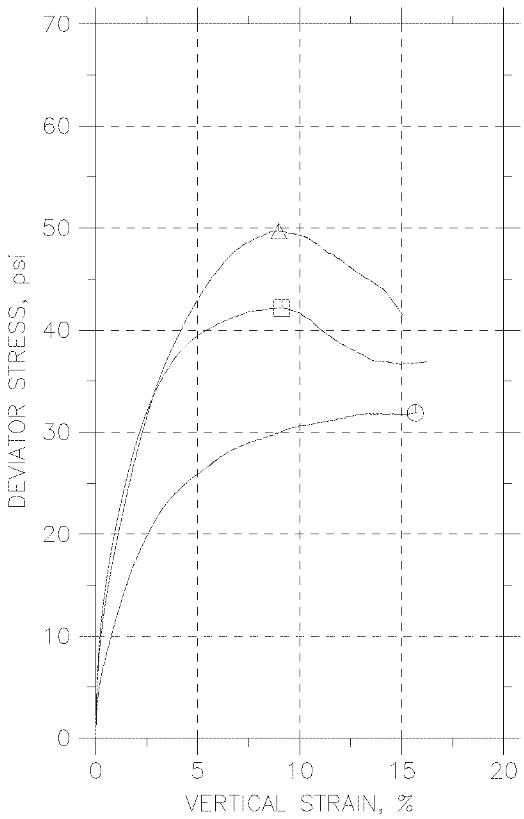
Project: Clifty Creek	Location: Jefferson, IN.	Project No.: GTX-1516
Boring No.: B-8	Sample Type: UD	
Description: Greenish brown lean clay with sand		
Remarks: 2054		

Tue, 19-JAN-2010 09:45:54

CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767





	Symbol	○	△	□	
	Sample No.	---	---	---	
	Test No.	3.1	3.2	3.3	
	Depth	17.4-18.0	19.4-20.0	20.8--21.4	
Initial	Diameter, in	2.835	2.835	2.837	
	Height, in	6.319	6.281	6.177	
	Water Content, %	19.4	18.4	20.8	
	Dry Density, pcf	109.7	111.4	107.3	
	Saturation, %	97.8	96.9	98.6	
	Void Ratio	0.536	0.514	0.571	
Before Shear	Water Content, %	19.2	18.9	22.7	
	Dry Density, pcf	111.	111.7	104.5	
	Saturation*, %	100.0	100.0	100.0	
	Void Ratio	0.518	0.509	0.613	
	Back Press., psi	136.8	122	116.2	
	Ver. Eff. Cons. Stress, psi	9.997	19.96	29.88	
	Shear Strength, psi	15.94	24.86	21.08	
	Strain at Failure, %	15.7	8.98	9.12	
	Strain Rate, %/min	0.016	0.016	0.016	
	B-Value	0.95	0.96	0.95	
	Estimated Specific Gravity	2.7	2.7	2.7	
	Liquid Limit	---	---	---	
	Plastic Limit	---	---	---	

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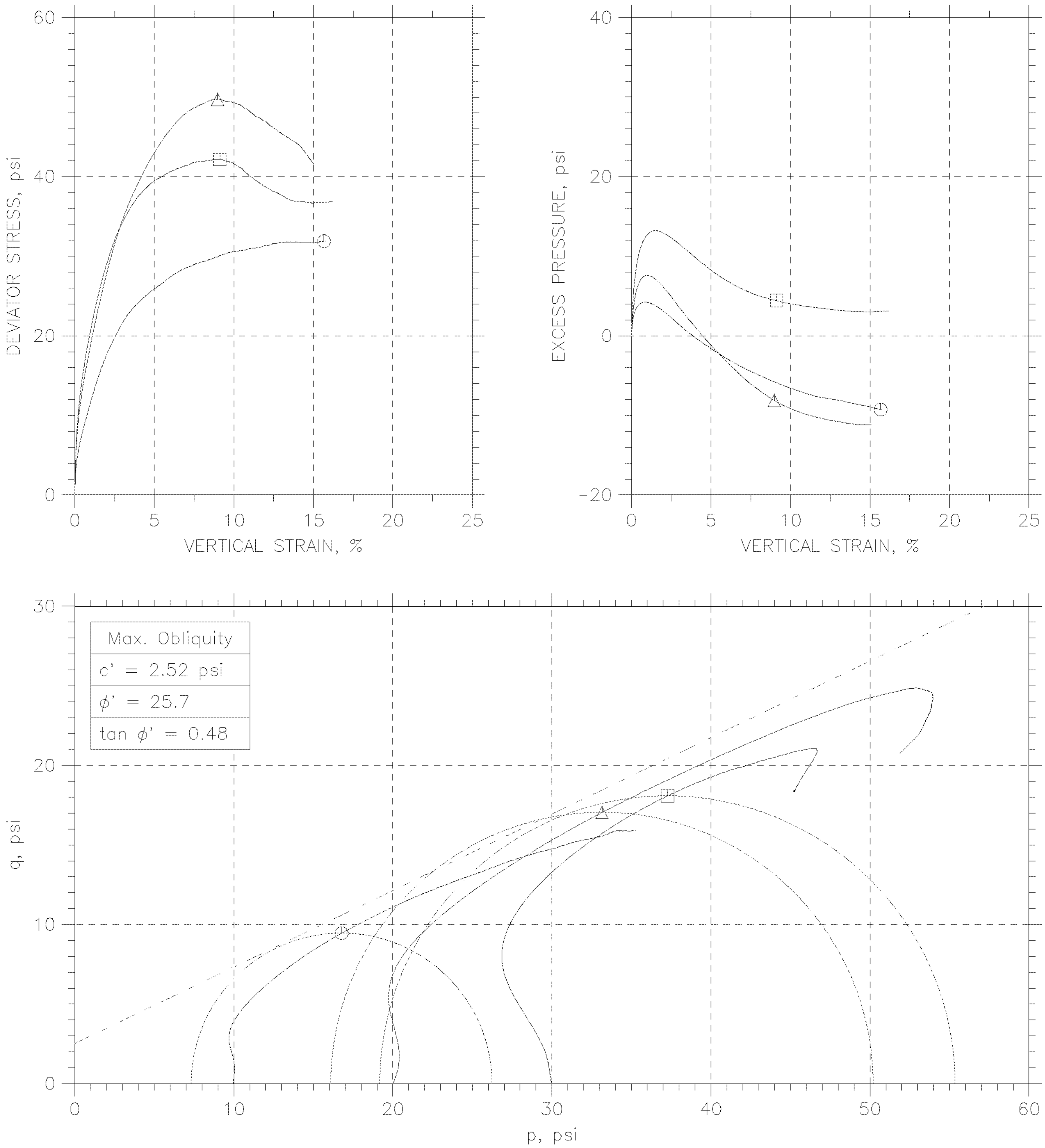
Project: Clifty Creek
Location: Jefferson, IN
Project No.: GTX-1516
Boring No.: B-9
Sample Type: UD
Description: Brown lean clay with sand
Remarks: System 1057

Tue, 19-JAN-2010 10:34:11

CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767



	Sample No.	Test No.	Depth	Tested By	Test Date	Checked By	Check Date	Test File
○	---	3.1	17.4-18.0	jm	12/15/09	mm		1516-3.1.dat
△	---	3.2	19.4-20.0	jm	12/16/09	mm		1516-3.2Adat.dat
□	---	3.3	20.8--21.4	jm	12/10/09	mm		1516-3.3.dat

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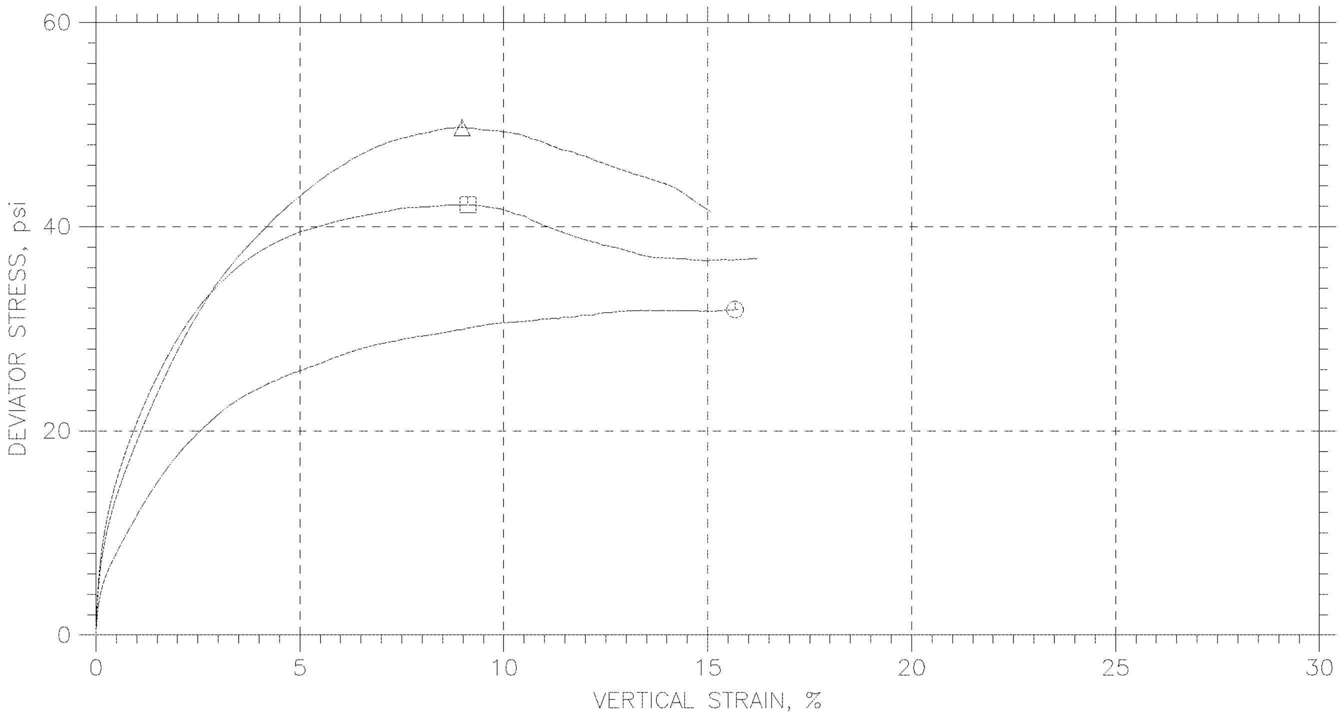
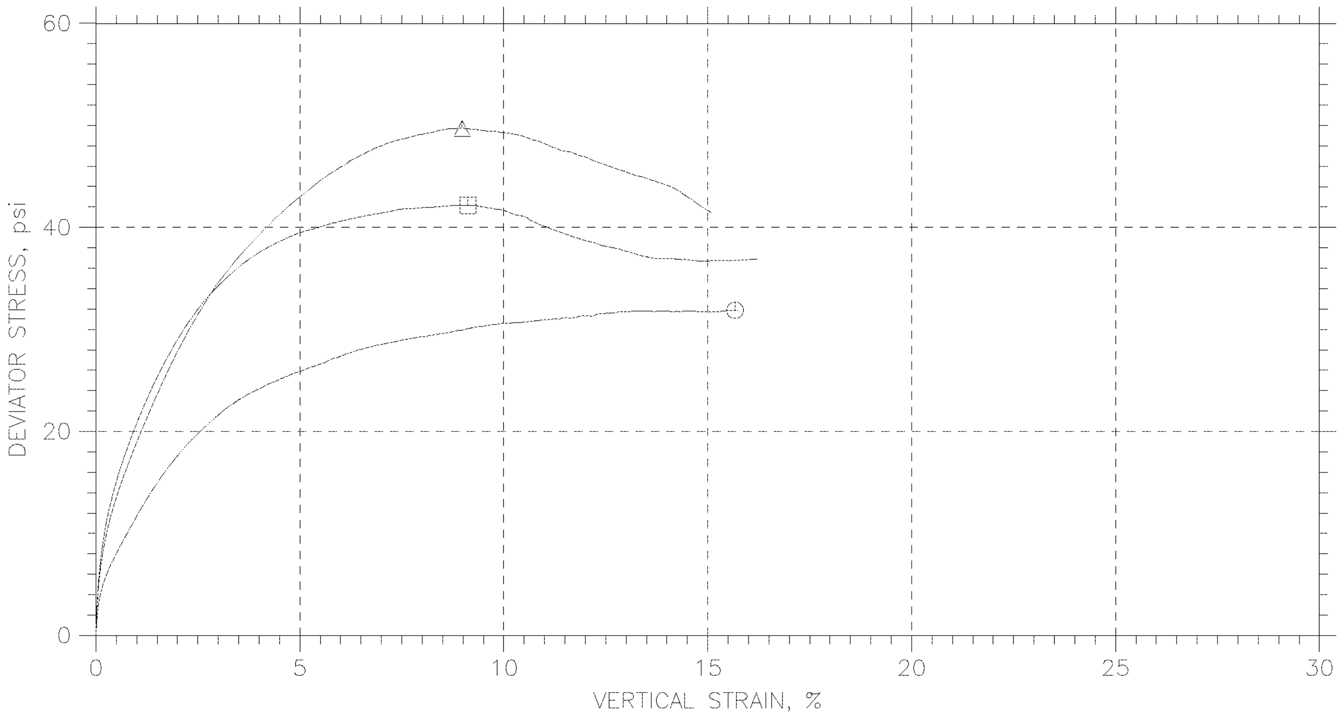
Project: Clifty Creek	Location: Jefferson, IN	Project No.: GTX-1516
Boring No.: B-9	Sample Type: UD	
Description: Brown lean clay with sand		
Remarks: System 1057		

Tue, 19-JAN-2010 10:34:12

CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767





	Sample No.	Test No.	Depth	Tested By	Test Date	Checked By	Check Date	Test File
⏀	---	3.1	17.4-18.0	jm	12/15/09	mm		1516-3.1.dat
△	---	3.2	19.4-20.0	jm	12/16/09	mm		1516-3.2Adat.dat
◫	---	3.3	20.8--21.4	jm	12/10/09	mm		1516-3.3.dat

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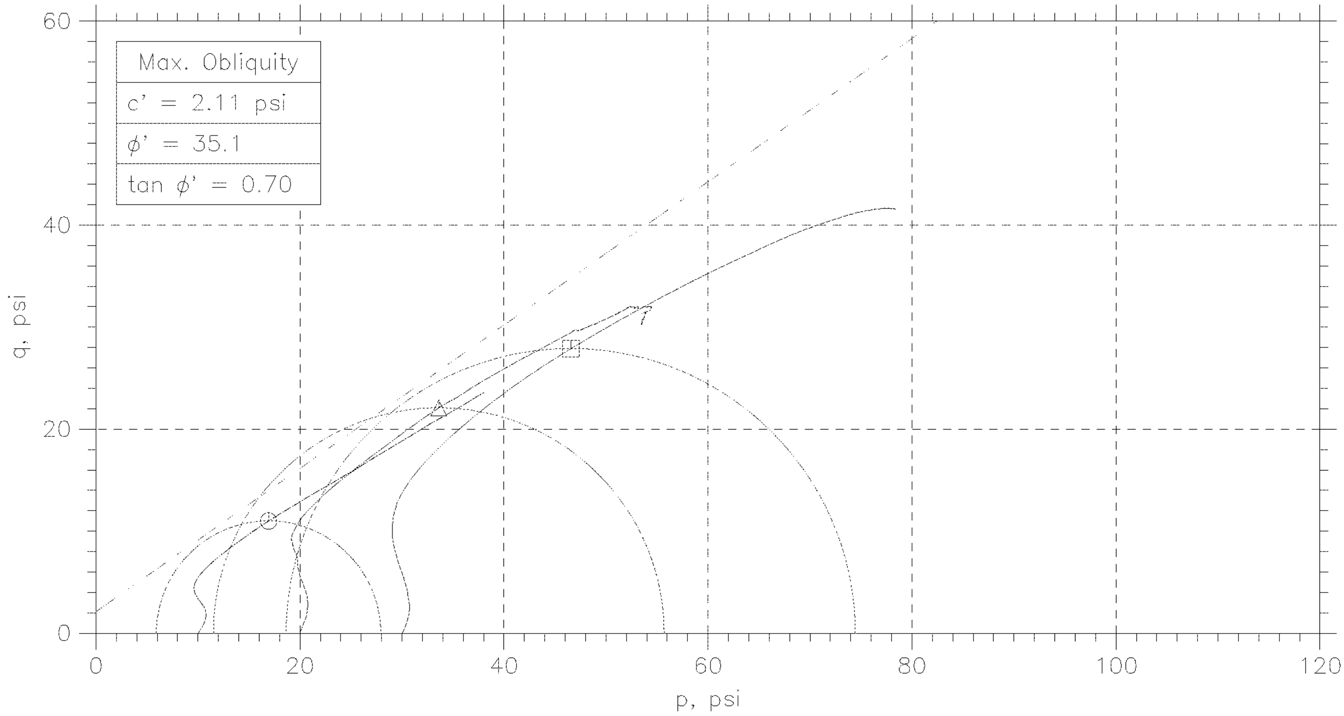
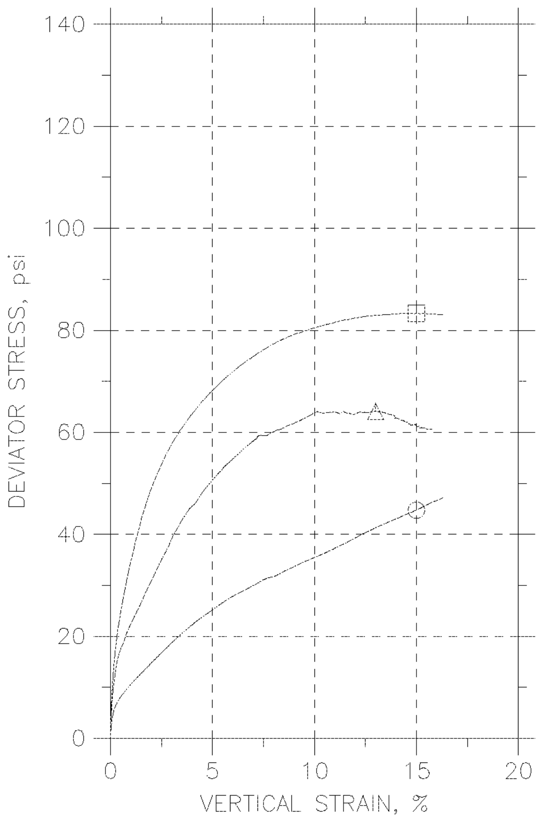
Project: Clifty Creek	Location: Jefferson, IN	Project No.: GTX-1516
Boring No.: B-9	Sample Type: UD	
Description: Brown lean clay with sand		
Remarks: System 1057		

Tue, 19-JAN-2010 10:34:14

CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767





	Symbol	○	△	□	
	Sample No.	---	----	----	
	Test No.	CU-4.1	CU-4.2	CU-4.3	
	Depth	13.4-14.0'	16.8-17.4'	17.4-18.'	
Initial	Diameter, in	2.83	2.71	2.72	
	Height, in	5.78	5.52	5.51	
	Water Content, %	14.2	27.4	26.6	
	Dry Density, pcf	102.9	93.8	93.72	
	Saturation, %	59.9	93.0	89.9	
	Void Ratio	0.638	0.797	0.798	
Before Shear	Water Content, %	23.2	18.5	19.2	
	Dry Density, pcf	103.7	112.4	111.	
	Saturation*, %	100.0	100.0	100.0	
	Void Ratio	0.625	0.5	0.519	
	Back Press., psi	27.99	73	84.99	
	Ver. Eff. Cons. Stress, psi	10	19.99	30	
	Shear Strength, psi	22.37	32.06	41.66	
	Strain at Failure, %	15	13	15	
	Strain Rate, %/min	0.032	0.032	0.032	
	B-Value	0.95	0.95	0.96	
	Estimated Specific Gravity	2.7	2.7	2.7	
	Liquid Limit	---	---	---	
	Plastic Limit	---	---	---	

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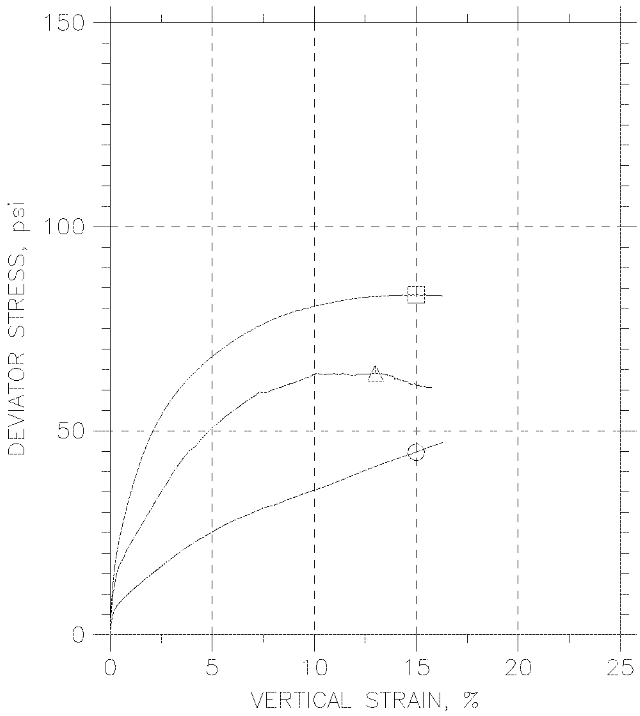
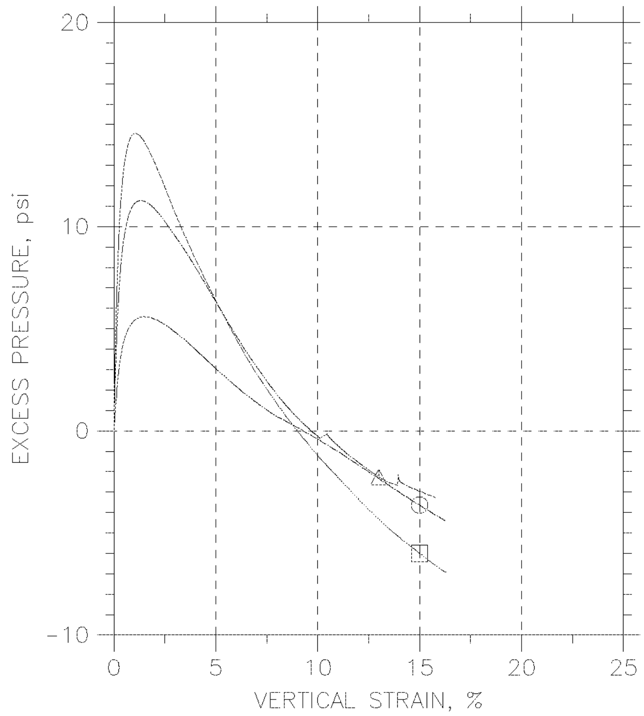
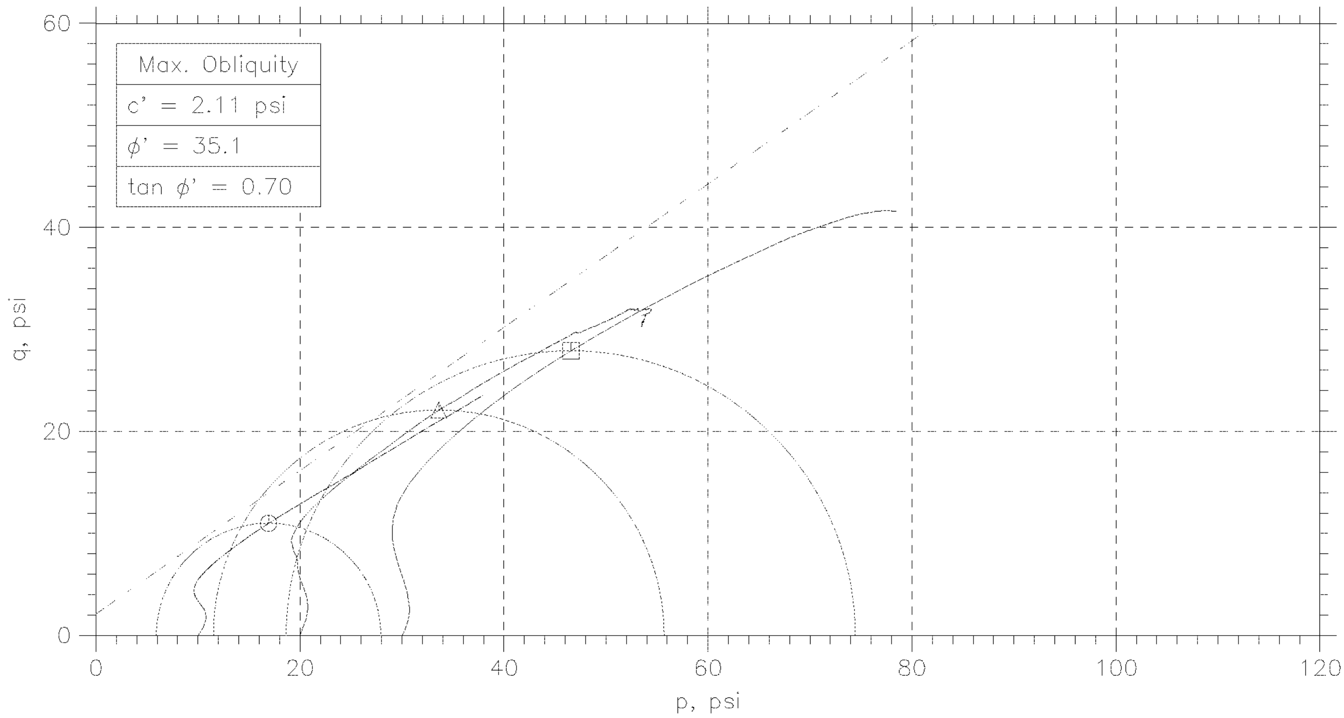
Project: Clifty Creek	
Location: ----	
Project No.: GTX-1516	
Boring No.: B-10	
Sample Type: UD	
Description:	
Remarks: 2054	

Tue, 19-JAN-2010 11:56:28

CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767







	Sample No.	Test No.	Depth	Tested By	Test Date	Checked By	Check Date	Test File
○	---	CU-4.1	13.4-14.0'	JM	12/12/09	MM		1516-4.1.dat
△	----	CU-4.2	16.8-17.4'	JM	12/13/09	MM		1516-4.2.dat
□	----	CU-4.3	17.4-18.'	JM	12/12/09	MM		1516-4.3.dat

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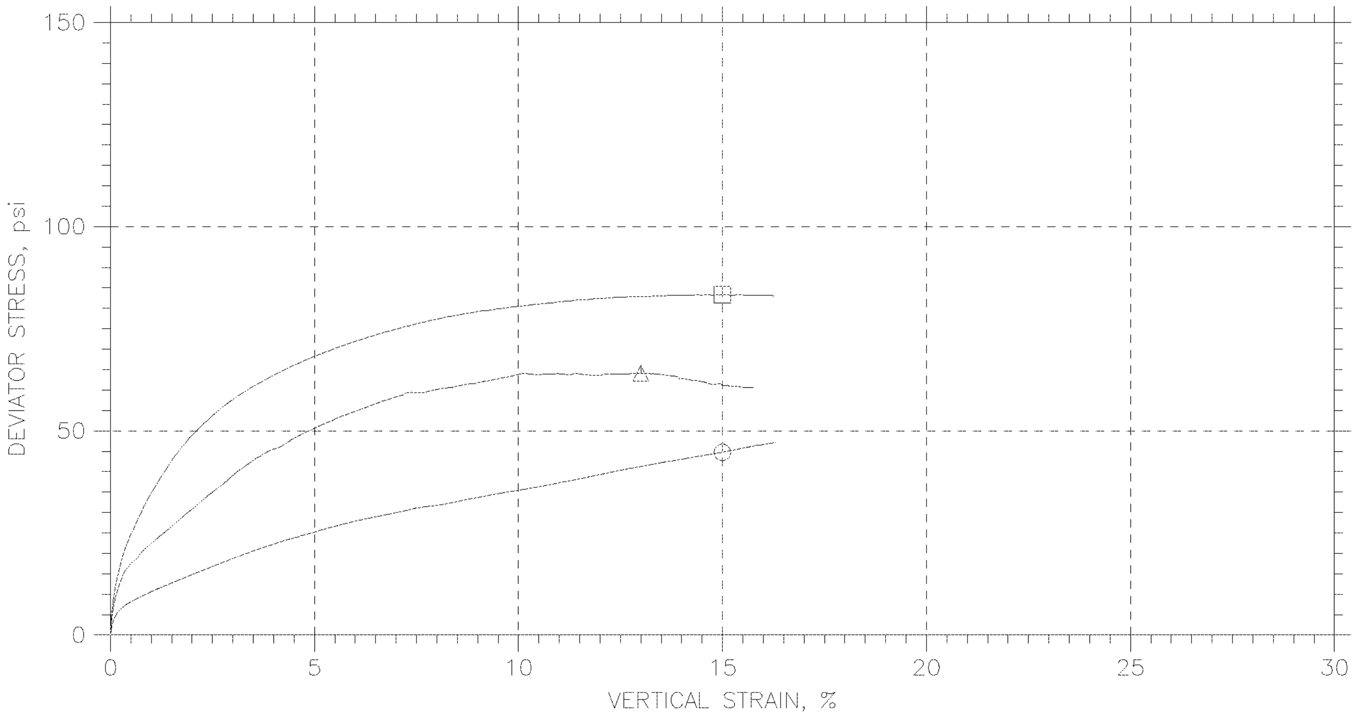
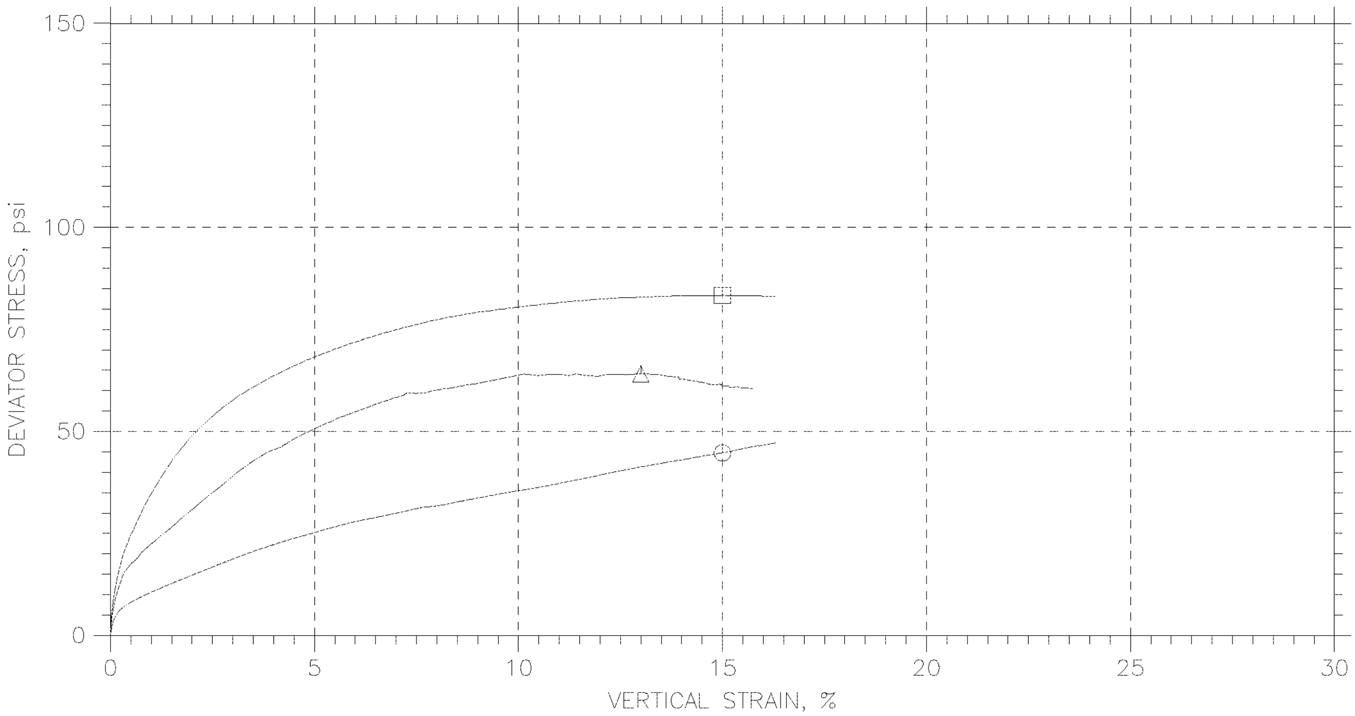
Project: Clifty Creek	Location: ----	Project No.: GTX-1516
Boring No.: B-10	Sample Type: UD	
Description:		
Remarks: 2054		

Tue, 19-JAN-2010 11:56:29

CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767





	Sample No.	Test No.	Depth	Tested By	Test Date	Checked By	Check Date	Test File
○	---	CU-4.1	13.4-14.0'	JM	12/12/09	MM		1516-4.1.dat
△	----	CU-4.2	16.8-17.4'	JM	12/13/09	MM		1516-4.2.dat
□	----	CU-4.3	17.4-18.'	JM	12/12/09	MM		1516-4.3.dat

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Project: Clifty Creek	Location: ----	Project No.: GTX-1516
Boring No.: B-10	Sample Type: UD	
Description:		
Remarks: 2054		

Tue, 19-JAN-2010 11:56:31

APPENDIX F

PERMEABILITY TESTS

BOILER SLAB POND DAM

Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter ASTM D 5084-03

Project Name AEP-Clifty Creek-West Bottom Ash and Fly Ash Ponds subsurface exploration — Project No. 175539022
Source B-1, 15.0'-17.0', TI 16.1'-16.6' — Test ID 7A
Visual Classification Lean Clay (CL), brown, moist, firm — Prepared By CSM
Undisturbed XX — Specific Gravity 2.72 ASTM D854-A — Date 12-9-09
Maximum Dry Density (pcf) ______ Percent of Maximum ______
Permeant: De-aired tap water
Selection and Preparation Comments:

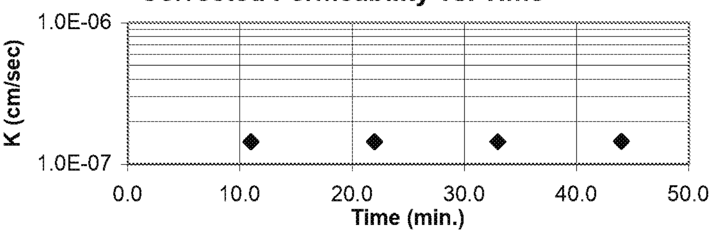
Specimens (if compacted) were compacted in a Proctor Mold as follows: The Maximum Dry Density was converted to Wet Density, this mass was divided by 4 (layers) and 3 of the 4 layers were compacted into the mold using a Proctor Hammer using 19 blows per layer. The density was varied by reducing the height of the drop by the amount listed beside "Compacted". The specimen was trimmed from the bottom two layers.

	Initial Specimen Data	After Consolidation Data	After Test Data	Final Pressures (psi)	
Height (in.)	1.4783	1.4675	1.4676	Chamber	75
Diameter (in.)	2.8043		2.8179	Influent	70
Moisture Content (%)	19.7		20.8	Effluent	65
Dry Unit Weight (pcf)	109.5		109.2		
Void Ratio	0.551		0.555		
Degree of Saturation (%)	97.3		101.9		
Trimmings MC (%)	19.6				

Applied Head Difference (psi) 5
Back Pressure Saturated to (psi) 65
Maximum Effective Consolidation Stress (psi) 10
Minimum Effective Consolidation Stress (psi) 5

Date	Clock (24H:M)	Temp. °F	Bottom Head	Top Head	Test Time (sec)	Hydraulic Conductivity k (m/s)	k (cm/s)	k @ 20° C (m/s)	k @ 20° C (cm/s)
12-21-09	10:24	73.0	15.02	8.57	0	---	---	---	---
12-21-09	10:35	73.0	14.90	8.69	6.60E+02	1.5E-09	1.5E-07	1.4E-09	1.4E-07
12-21-09	10:46	73.0	14.78	8.81	6.60E+02	1.5E-09	1.5E-07	1.4E-09	1.4E-07
12-21-09	10:57	73.0	14.66	8.93	6.60E+02	1.5E-09	1.5E-07	1.4E-09	1.4E-07
12-21-09	11:08	73.0	14.54	9.05	6.60E+02	1.5E-09	1.5E-07	1.4E-09	1.4E-07

Corrected Permeability vs. Time



A gradient of approximately 93.4 was used for this test. This gradient exceeds ASTM guidelines for maximum gradient, but was used to achieve the requestors desired test duration. Examination of the sample shows no signs of material loss or clogging that may affect test results.

Average Hydraulic Conductivity @ 20° C (last 4 determinations) m/s 1.44E-09 cm/s 1.44E-07
Average Hydraulic Conductivity @ 20° C (last run) m/s 1.44E-09 cm/s 1.44E-07

Reviewed by: __________

Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter ASTM D 5084-03

Stantec

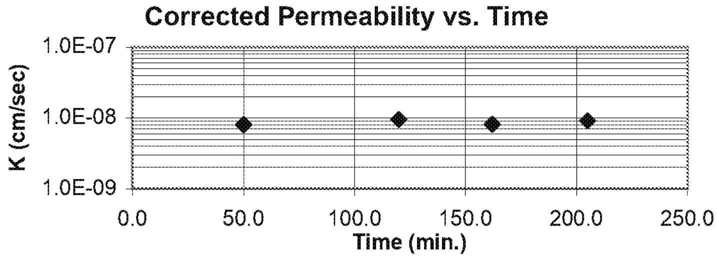
Project Name: AEP-Clifty Creek-West Bottom Ash and Fly Ash Ponds subsurface exploration
Project No. 175539022
Source: B-2, 42.5'-44.5', TI 42.6'-43.1'
Test ID 48A
Visual Classification: Lean Clay (CL), gray, wet, soft
Prepared By CSM
Undisturbed XX
Specific Gravity 2.69 ASTM D854-A
Date 11-30-09
Maximum Dry Density (pcf)
Percent of Maximum
Permeant: De-aired tap water
Selection and Preparation Comments:

Specimens (if compacted) were compacted in a Proctor Mold as follows: The Maximum Dry Density was converted to Wet Density, this mass was divided by 4 (layers) and 3 of the 4 layers were compacted into the mold using a Proctor Hammer using 19 blows per layer. The density was varied by reducing the height of the drop by the amount listed beside "Compacted". The specimen was trimmed from the bottom two layers.

	Initial Specimen Data	After Consolidation Data	After Test Data	Final Pressures (psi)	
Height (in.)	1.4906	1.3473	1.3472	Chamber	75
Diameter (in.)	2.8023		2.8480	Influent	70
Moisture Content (%)	31.6		26.0	Effluent	65
Dry Unit Weight (pcf)	91.6		98.1		
Void Ratio	0.834		0.712		
Degree of Saturation (%)	101.8		98.1		
Trimmings MC (%)	30.9				

Applied Head Difference (psi) 5
Back Pressure Saturated to (psi) 65
Maximum Effective Consolidation Stress (psi) 10
Minimum Effective Consolidation Stress (psi) 5

						Hydraulic Conductivity			
Date	Clock (24H:M)	Temp. °F	Bottom Head	Top Head	Test Time (sec)	k (m/s)	k (cm/s)	k @ 20° C (m/s)	k @ 20° C (cm/s)
12-22-09	8:20	70.0	22.26	3.46	0	---	---	---	---
12-22-09	9:10	70.0	22.13	3.59	3.00E+03	8.3E-11	8.3E-09	8.1E-11	8.1E-09
12-22-09	10:20	70.0	21.92	3.81	4.20E+03	9.8E-11	9.8E-09	9.5E-11	9.5E-09
12-22-09	11:02	70.0	21.81	3.92	2.52E+03	8.4E-11	8.4E-09	8.1E-11	8.1E-09
12-22-09	11:45	70.0	21.68	4.04	2.58E+03	9.3E-11	9.3E-09	9.1E-11	9.1E-09



A gradient of approximately 92.6 was used for this test. This gradient exceeds ASTM guidelines for maximum gradient, but was used to achieve the requestors desired test duration. Examination of the sample shows no signs of material loss or clogging that may affect test results.

Average Hydraulic Conductivity @ 20° C (last 4 determinations) m/s 8.70E-11 cm/s 8.70E-09
Average Hydraulic Conductivity @ 20° C (last run) m/s 8.70E-11 cm/s 8.70E-09

Reviewed by: ____________

Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter ASTM D 5084-03

Project Name AEP-Clifty Creek- West Bottom Ash and Fly Ash Ponds subsurface exploration — Project No. 175539022
Source B-4, 7.5'-9.5', TI 7.6'-8.1' — Test ID 82A
Visual Classification Lean Clay (CL), brown, moist, firm, organic odor — Prepared By CSM
Undisturbed XX — Specific Gravity 2.7 ASTM D854-A — Date 12-9-09
Maximum Dry Density (pcf) ______ Percent of Maximum ______
Permeant: De-aired tap water
Selection and Preparation Comments:

Specimens (if compacted) were compacted in a Proctor Mold as follows: The Maximum Dry Density was converted to Wet Density, this mass was divided by 4 (layers) and 3 of the 4 layers were compacted into the mold using a Proctor Hammer using 19 blows per layer. The density was varied by reducing the height of the drop by the amount listed beside "Compacted". The specimen was trimmed from the bottom two layers.

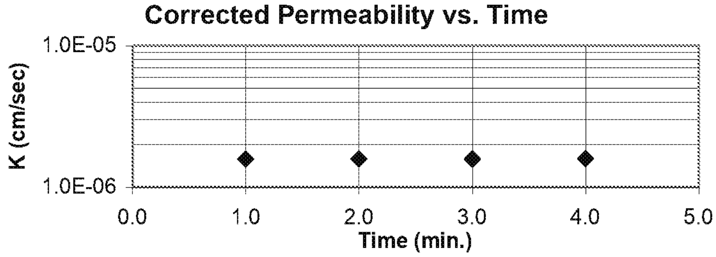
	Initial Specimen Data	After Consolidation Data	After Test Data
Height (in.)	1.4754	1.4631	1.4654
Diameter (in.)	2.8057		2.8200
Moisture Content (%)	18.8		20.1
Dry Unit Weight (pcf)	110.0		109.6
Void Ratio	0.532		0.537
Degree of Saturation (%)	95.6		100.8
Trimmings MC (%)	19.1		

Final Pressures (psi)	
Chamber	75
Influent	70
Effluent	65

Applied Head Difference (psi) 5
Back Pressure Saturated to (psi) 65
Maximum Effective Consolidation Stress (psi) 10
Minimum Effective Consolidation Stress (psi) 5

						Hydraulic Conductivity			
Date	Clock (24H:M)	Temp. °F	Bottom Head	Top Head	Test Time (sec)	k (m/s)	k (cm/s)	k @ 20° C (m/s)	k @ 20° C (cm/s)
12-21-09	11:25	73.0	15.06	10.34	0	---	---	---	---
12-21-09	11:26	73.0	14.94	10.46	6.00E+01	1.7E-08	1.7E-06	1.6E-08	1.6E-06
12-21-09	11:27	73.0	14.82	10.58	6.00E+01	1.7E-08	1.7E-06	1.6E-08	1.6E-06
12-21-09	11:28	73.0	14.70	10.70	6.00E+01	1.7E-08	1.7E-06	1.6E-08	1.6E-06
12-21-09	11:29	73.0	14.58	10.82	6.00E+01	1.7E-08	1.7E-06	1.6E-08	1.6E-06

Corrected Permeability vs. Time



A gradient of approximately 93.5 was used for this test. This gradient exceeds ASTM guidelines for maximum gradient, but was used to achieve the requestors desired test duration. Examination of the sample shows no signs of material loss or clogging that may affect test results.

Average Hydraulic Conductivity @ 20° C (last 4 determinations) m/s 1.58E-08 cm/s 1.58E-06
Average Hydraulic Conductivity @ 20° C (last run) m/s 1.58E-08 cm/s 1.58E-06

Reviewed by: ______

Stantec

Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter ASTM D 5084-03

Project Name AEP-Clifty Creek-West Bottom Ash and Fly Ash Ponds subsurface exploration — Project No. 175539022
Source B-6, 17.5'-19.0', TI 17.6'-18.1' — Test ID 291
Visual Classification Lean Clay (CL), brown, moist, firm — Prepared By CSM
Undisturbed XX — Specific Gravity 2.68 ASTM D854-A — Date 12-9-09
Maximum Dry Density (pcf) ____ Percent of Maximum ____
Permeant: De-aired tap water
Selection and Preparation Comments:

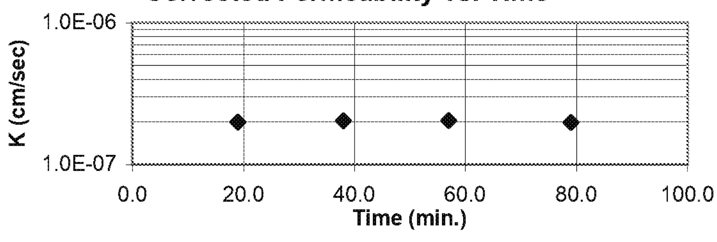
Specimens (if compacted) were compacted in a Proctor Mold as follows: The Maximum Dry Density was converted to Wet Density, this mass was divided by 4 (layers) and 3 of the 4 layers were compacted into the mold using a Proctor Hammer using 19 blows per layer. The density was varied by reducing the height of the drop by the amount listed beside "Compacted". The specimen was trimmed from the bottom two layers.

	Initial Specimen Data	After Consolidation Data	After Test Data	Final Pressures (psi)	
Height (in.)	1.4778	1.4443	1.4478	Chamber	75
Diameter (in.)	2.8030		2.7955	Influent	70
Moisture Content (%)	32.0		33.2	Effluent	65
Dry Unit Weight (pcf)	87.1		89.4		
Void Ratio	0.921		0.872		
Degree of Saturation (%)	93.1		102.1		
Trimmings MC (%)	33.1				

Applied Head Difference (psi) 5
Back Pressure Saturated to (psi) 65
Maximum Effective Consolidation Stress (psi) 10
Minimum Effective Consolidation Stress (psi) 5

Date	Clock (24H:M)	Temp. °F	Bottom Head	Top Head	Test Time (sec)	Hydraulic Conductivity k (m/s)	k (cm/s)	k @ 20° C (m/s)	k @ 20° C (cm/s)
12-21-09	13:10	73.0	19.94	4.28	0	---	---	---	---
12-21-09	13:29	73.0	19.65	4.56	1.14E+03	2.1E-09	2.1E-07	2.0E-09	2.0E-07
12-21-09	13:48	73.0	19.36	4.85	1.14E+03	2.2E-09	2.2E-07	2.0E-09	2.0E-07
12-21-09	14:07	73.0	19.07	5.14	1.14E+03	2.2E-09	2.2E-07	2.0E-09	2.0E-07
12-21-09	14:29	73.0	18.71	5.43	1.32E+03	2.1E-09	2.1E-07	2.0E-09	2.0E-07

Corrected Permeability vs. Time



A gradient of approximately 93.4 was used for this test. This gradient exceeds ASTM guidelines for maximum gradient, but was used to achieve the requestors desired test duration. Examination of the sample shows no signs of material loss or clogging that may affect test results.

Average Hydraulic Conductivity @ 20° C (last 4 determinations) m/s 2.01E-09 cm/s 2.01E-07
Average Hydraulic Conductivity @ 20° C (last run) m/s 2.01E-09 cm/s 2.01E-07

Reviewed by: ____

LANDFILL RUNOFF COLLECTION POND

PERMEABILITY TEST
(ASTM D5084 - 90) (Method C, Increasing Tailwater Level)

Project Number	GTX-1516	Tested By	JM
Project Name	Clifty Creek	Test Date	12/12/10
Boring No.	B-7	Reviewed By	MM
Sample No.	---	Review Date	12/15/10
Sample Depth	27.4-27.7 ft	Lab No.	5
Sample Description	Lean clay		

GeoTesting express

Sample Data

Length, in		Diameter, in		Pan No.	CS-1
Location 1	2.831	Location 1	2.825	Dry Soil+Pan, grams	484.22
Location 2	2.830	Location 2	2.825	Pan Weight, grams	8.17
Location3	2.829	Location 3	2.825		
Average	2.830	Average	2.825	Moisture Content, %	24.6
		Wet Soil + Tare, grams	593.33	Wet Unit Weight, pcf	127.4
		Tare Weight, grams	0.00	Dry Unit Weight, pcf	102.2

Remarks:

Chamber Pressure, psi	65
Back Pressure, psi	60
Confining Pressure, psi	5

Date Start	Date Finish	Time Start	Time Finish	Time (sec)	H_a (cm)	H_1 (cm)	H_b (cm)	H_2 (cm)	k cm/sec	Temp (°C)	k cm/sec at 20 °C
				2820	9.9	100.3	10.60	99.5	8.4E-08	22	8.1E-08
				6300	9.9	100.3	11.80	98.4	9.7E-08	24	8.8E-08
				9000	9.9	100.3	12.50	97.7	9.4E-08	24	8.5E-08
				14400	9.9	100.3	14.00	96.1	9.5E-08	24	8.6E-08
				27000	9.9	100.3	17.00	93	9.1E-08	24	8.3E-08

No. of Trials	Sample Type	Max. Density (pcf)	Compaction %	Sample Orientation
5	UD	102.2	N/A	Vertical

Avg. k at 20 °C 8.4E-08 cm/sec

a = area of burette in cm²
L = length of sample in cm
A = area of sample in cm²

Ha = initial inlet head in cm
H_1 = initial outlet head in cm
t = time in seconds

H_b = final inlet head in cm
H_2 = final outlet head in cm

a = 0.16 cm²
A = 40.44 cm²
L = 7.19 cm

GeoTesting express

HYDRAULIC CONDUCTIVITY

Project No.	*GTX-1516*	Tested By	*JM*
Project Name	*Clifty Creek*	Test Date	*12/12/2010*
Boring No.	*B-7*	Reviewed By	*MM*
Sample No.	---	Review Date	*12/15/2010*
Sample Depth	*27.4-27.7 ft*	Lab No.	*5*
Sample Description	*Lean clay*		

ASTM D5084 - Falling Head (Method C RisingTail)

Sample Type:	*UD*
Sample Orientation:	*Vertical*
Initial Water Content, %:	*24.6*
Wet Unit Weight, pcf:	*127.4*
Dry Unit Weight, pcf:	*102.2*
Compaction, %:	*N/A*
Hydraulic Conductivity, cm/sec. @20 °C	***8.4E-08***

Remarks: ______________________

PERMEABILITY TEST
(ASTM D5084 - 90) (Method C, Increasing Tailwater Level)

Project Number	GTX-1516	Tested By	JM
Project Name	Clifty Creek	Test Date	12/12/10
Boring No.	B-8	Reviewed By	MM
Sample No.	---	Review Date	12/15/10
Sample Depth	29.7-30.3 ft	Lab No.	7
Sample Description	Lean clay with sand		

GeoTesting express

Sample Data

Length, in		Diameter, in		Pan No.	A44
Location 1	2.841	Location 1	2.775	Dry Soil+Pan, grams	487.70
Location 2	2.843	Location 2	2.784	Pan Weight, grams	8.99
Location3	2.844	Location 3	2.788		
Average	2.843	Average	2.782	Moisture Content, %	23.5
		Wet Soil + Tare, grams	591.11	Wet Unit Weight, pcf	130.3
		Tare Weight, grams	0.00	Dry Unit Weight, pcf	105.5

Remarks:

Chamber Pressure, psi	65
Back Pressure, psi	60
Confining Pressure, psi	5

Date Start	Date Finish	Time Start	Time Finish	Time (sec)	H_a (cm)	H_1 (cm)	H_b (cm)	H_2 (cm)	k cm/sec	Temp (°C)	k cm/sec at 20 °C
				3200	6.5	107.2	6.90	106.9	3.2E-08	22	3.1E-08
				6600	6.5	107.2	7.40	106.4	3.8E-08	24	3.4E-08
				11400	6.5	107.2	8.10	105.7	4.0E-08	24	3.7E-08
				18000	6.5	107.2	9.00	104.8	4.1E-08	24	3.7E-08
				30000	6.5	107.2	10.20	103.6	3.7E-08	24	3.3E-08

No. of Trials	Sample Type	Max. Density (pcf)	Compaction %	Sample Orientation
5	UD	105.5	N/A	Vertical

Avg. k at 20 °C 3.4E-08 cm/sec

a = area of burette in cm^2
L = length of sample in cm
A = area of sample in cm^2
Ha = initial inlet head in cm
H_1 = initial outlet head in cm
t = time in seconds
H_b = final inlet head in cm
H_2 = final outlet head in cm

a = 0.16 cm^2
A = 39.23 cm^2
L = 7.22 cm

GeoTesting
express

HYDRAULIC CONDUCTIVITY

Project No.	*GTX-1516*	Tested By	*JM*
Project Name	*Clifty Creek*	Test Date	*12/12/2010*
Boring No.	*B-8*	Reviewed By	*MM*
Sample No.	---	Review Date	*12/15/2010*
Sample Depth	*29.7-30.3 ft*	Lab No.	*7*
Sample Description	*Lean clay with sand*		

ASTM D5084 - Falling Head (Method C RisingTail)

Sample Type:	*UD*
Sample Orientation:	*Vertical*
Initial Water Content, %:	*23.5*
Wet Unit Weight, pcf:	*130.3*
Dry Unit Weight, pcf:	*105.5*
Compaction, %:	*N/A*
Hydraulic Conductivity, cm/sec. @20 °C	***3.4E-08***

Remarks: ______________________________

PERMEABILITY TEST
(ASTM D5084 - 90) (Method C, Increasing Tailwater Level)

GeoTesting express

Project Number	GTX-1516	Tested By	JM
Project Name	Clifty Creek	Test Date	12/12/10
Boring No.	B-9	Reviewed By	MM
Sample No.	---	Review Date	12/15/10
Sample Depth	18.3-18.6	Lab No.	8
Sample Description	Lean clay		

Sample Data

Length, in		Diameter, in		Pan No.	a-18
Location 1	2.899	Location 1	2.872	Dry Soil+Pan, grams	541.33
Location 2	2.901	Location 2	2.877	Pan Weight, grams	9.11
Location3	2.905	Location 3	2.877		
Average	2.902	Average	2.875	Moisture Content, %	21.0
		Wet Soil + Tare, grams	644.22	Wet Unit Weight, pcf	130.3
		Tare Weight, grams	0.00	Dry Unit Weight, pcf	107.6

Remarks:

Chamber Pressure, psi 65

Back Pressure, psi 60

Confining Pressure, psi 5

Date Start	Date Finish	Time Start	Time Finish	Time (sec)	H_a (cm)	H_1 (cm)	H_b (cm)	H_2 (cm)	k cm/sec	Temp (°C)	k cm/sec at 20 °C
				1800	5.3	100.4	5.70	100	6.6E-08	22	6.3E-08
				4800	5.3	100.4	6.40	99.3	6.9E-08	24	6.2E-08
				8400	5.3	100.4	7.20	98.5	6.8E-08	24	6.2E-08
				16200	5.3	100.4	8.80	96.9	6.6E-08	24	6.0E-08
				27000	5.3	100.4	11.00	94.7	6.7E-08	24	6.0E-08

No. of Trials	Sample Type	Max. Density (pcf)	Compaction %	Sample Orientation
5	UD	107.6	N/A	Vertical

Avg. k at 20 °C 6.2E-08 cm/sec

a = area of burette in cm^2 — Ha = initial inlet head in cm — H_b = final inlet head in cm — a = 0.16 cm^2

L = length of sample in cm — H_1 = initial outlet head in cm — H_2 = final outlet head in cm — A = 41.89 cm^2

A = area of sample in cm^2 — t = time in seconds — L = 7.37 cm

GeoTesting express

HYDRAULIC CONDUCTIVITY

Project No.	*GTX-1516*	Tested By	*JM*
Project Name	*Clifty Creek*	Test Date	*12/12/2010*
Boring No.	*B-9*	Reviewed By	*MM*
Sample No.	---	Review Date	*12/15/2010*
Sample Depth	*18.3-18.6*	Lab No.	*8*
Sample Description	*Lean clay*		

ASTM D5084 - Falling Head (Method C RisingTail)

Sample Type:	*UD*
Sample Orientation:	*Vertical*
Initial Water Content, %:	*21.0*
Wet Unit Weight, pcf:	*130.3*
Dry Unit Weight, pcf:	*107.6*
Compaction, %:	*N/A*
Hydraulic Conductivity, cm/sec. @20 °C	***6.2E-08***

Remarks:

PERMEABILITY TEST
(ASTM D5084 - 90) (Method C, Increasing Tailwater Level)

Project Number	GTX-1516	Tested By	JM
Project Name	Clifty Creek	Test Date	12/12/10
Boring No.	B-10	Reviewed By	MM
Sample No.	---	Review Date	12/15/10
Sample Depth	16.4-16.7 ft	Lab No.	11
Sample Description	Lean clay		

GeoTesting express

Sample Data

Length, in		Diameter, in		Pan No.	a-22
Location 1	3.121	Location 1	2.876	Dry Soil+Pan, grams	539.99
Location 2	3.203	Location 2	2.877	Pan Weight, grams	9.13
Location3	3.126	Location 3	2.877		
Average	3.150	Average	2.877	Moisture Content, %	21.1
		Wet Soil + Tare, grams	642.99	Wet Unit Weight, pcf	119.6
		Tare Weight, grams	0.00	Dry Unit Weight, pcf	98.8

Remarks:

Chamber Pressure, psi	65
Back Pressure, psi	60
Confining Pressure, psi	5

Date Start	Date Finish	Time Start	Time Finish	Time (sec)	H_a (cm)	H_1 (cm)	H_b (cm)	H_2 (cm)	k cm/sec	Temp (°C)	k cm/sec at 20 °C
				1800	7.7	99.3	8.50	98.5	1.5E-07	22	1.4E-07
				4800	7.7	99.3	9.90	97.1	1.6E-07	22	1.5E-07
				8400	7.7	99.3	11.20	94.7	1.7E-07	22	1.6E-07
				16200	7.7	99.3	13.00	92.9	1.3E-07	22	1.2E-07
				24000	7.7	99.3	15.00	90.9	1.2E-07	22	1.1E-07

No. of Trials	Sample Type	Max. Density (pcf)	Compaction %	Sample Orientation
5	UD	107.6	N/A	Vertical

Avg. k at 20 °C 1.4E-07 cm/sec

a = area of burette in cm²
L = length of sample in cm
A = area of sample in cm²

Ha = initial inlet head in cm
H_1 = initial outlet head in cm
t = time in seconds

H_b = final inlet head in cm
H_2 = final outlet head in cm

a = 0.16 cm²
A = 41.93 cm²
L = 8.00 cm

GeoTesting express

HYDRAULIC CONDUCTIVITY

Project No.	*GTX-1516*	Tested By	*JM*
Project Name	*Clifty Creek*	Test Date	*12/12/2010*
Boring No.	*B-10*	Reviewed By	*MM*
Sample No.	---	Review Date	*12/15/2010*
Sample Depth	*16.4-16.7 ft*	Lab No.	*11*
Sample Description	*Lean clay*		

ASTM D5084 - Falling Head (Method C RisingTail)

Sample Type:	*UD*
Sample Orientation:	*Vertical*
Initial Water Content, %:	*21.1*
Wet Unit Weight, pcf:	*119.6*
Dry Unit Weight, pcf:	*98.8*
Compaction, %:	*N/A*
Hydraulic Conductivity, cm/sec. @20 °C	***1.4E-07***

Remarks:

APPENDIX G

STANDARD PROCTOR MOISTURE-DENSITY TESTS

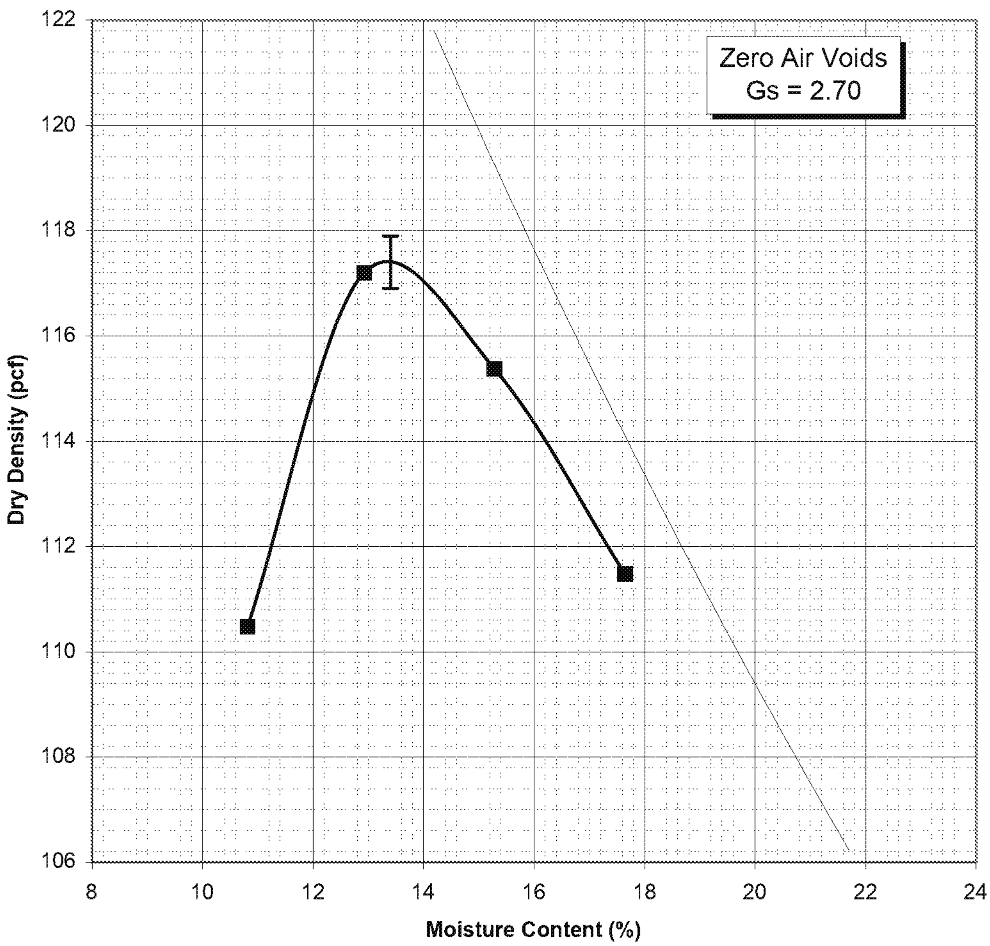
BOILER SLAG POND DAM

Moisture-Density Data Sheet

Stantec

Project: AEP - Clifty Creek - West Bottom Ash Pond
Project No.: 175539022
Source: B-1, 5.0'
Sample No.: 319
Sample Description: Brown lean clay with gravel, moist
Nmc: 15.6 %
Visual Notes: N/A
Test Method: ASTM D 698 - Method A
Prepared: Dry Oversized Fraction: < 5 % Rammer: Mechanical
Gs - Fines: Assumed

Mold Weight 2041 grams		Moisture Determination				
Wet Weight plus Mold (grams)	Wet Weight minus Mold (grams)	Wet Soil and Can Weight (grams)	Dry Soil and Can Weight (grams)	Can Weight (grams)	Water Content (%)	Dry Density (pcf)
3879	1838	432.75	397.39	70.52	10.8	110.5
4028	1987	462.87	418.39	74.30	12.9	117.2
4038	1997	405.73	362.08	76.62	15.3	115.4
4010	1969	368.39	324.37	74.94	17.6	111.5

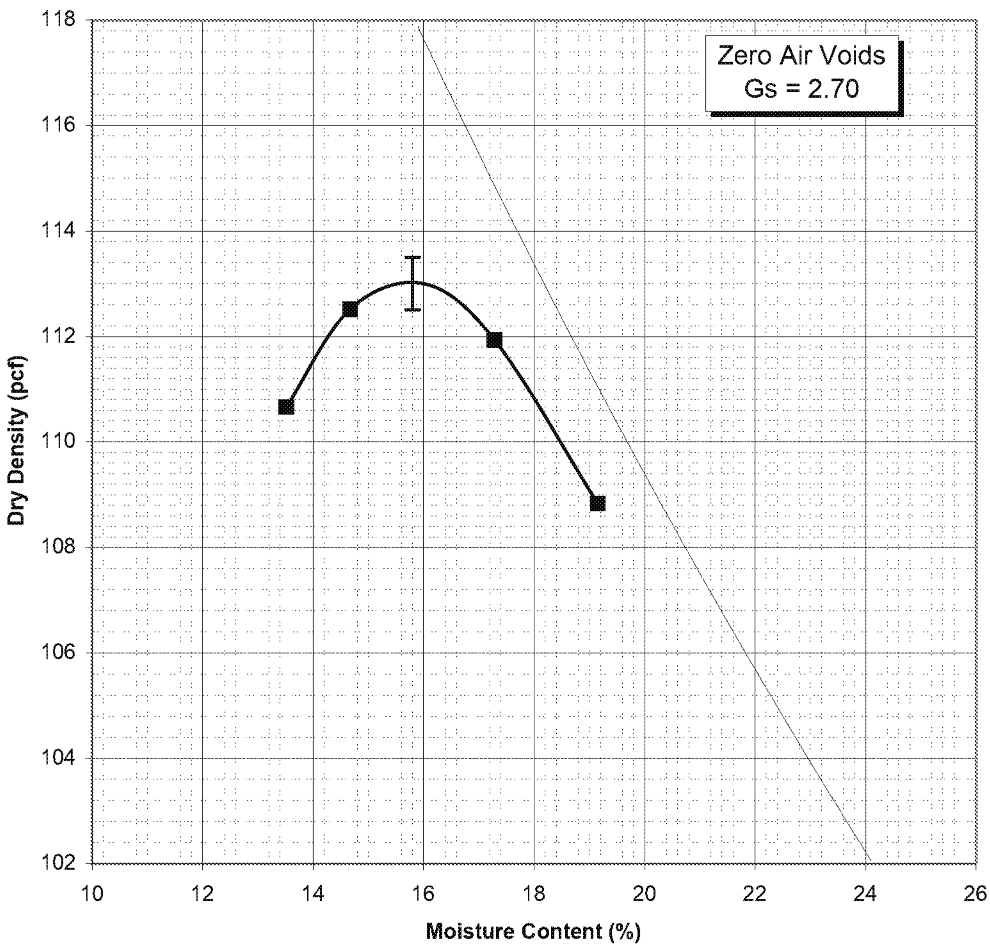


Maximum Dry Density 117.4 PCF
Optimum Moisture Content 13.4 %

Moisture-Density Data Sheet

Project: AEP - Clifty Creek - West Bottom Ash Pond
Project No.: 175539022
Source: B-5, 7.5'
Sample No.: 320
Sample Description: brown lean clay, moist
Nmc: 18.2 %
Visual Notes: N/A
Test Method: ASTM D 698 - Method A
Prepared: Dry   Oversized Fraction: < 5 %   Rammer: Mechanical
Gs - Fines: Assumed

Mold Weight 2041 grams		Moisture Determination				
Wet Weight plus Mold (grams)	Wet Weight minus Mold (grams)	Wet Soil and Can Weight (grams)	Dry Soil and Can Weight (grams)	Can Weight (grams)	Water Content (%)	Dry Density (pcf)
3927	1886	422.84	381.18	72.94	13.5	110.7
3978	1937	388.97	348.78	74.79	14.7	112.5
4012	1971	392.34	345.43	74.11	17.3	111.9
3988	1947	409.73	355.79	74.24	19.2	108.8



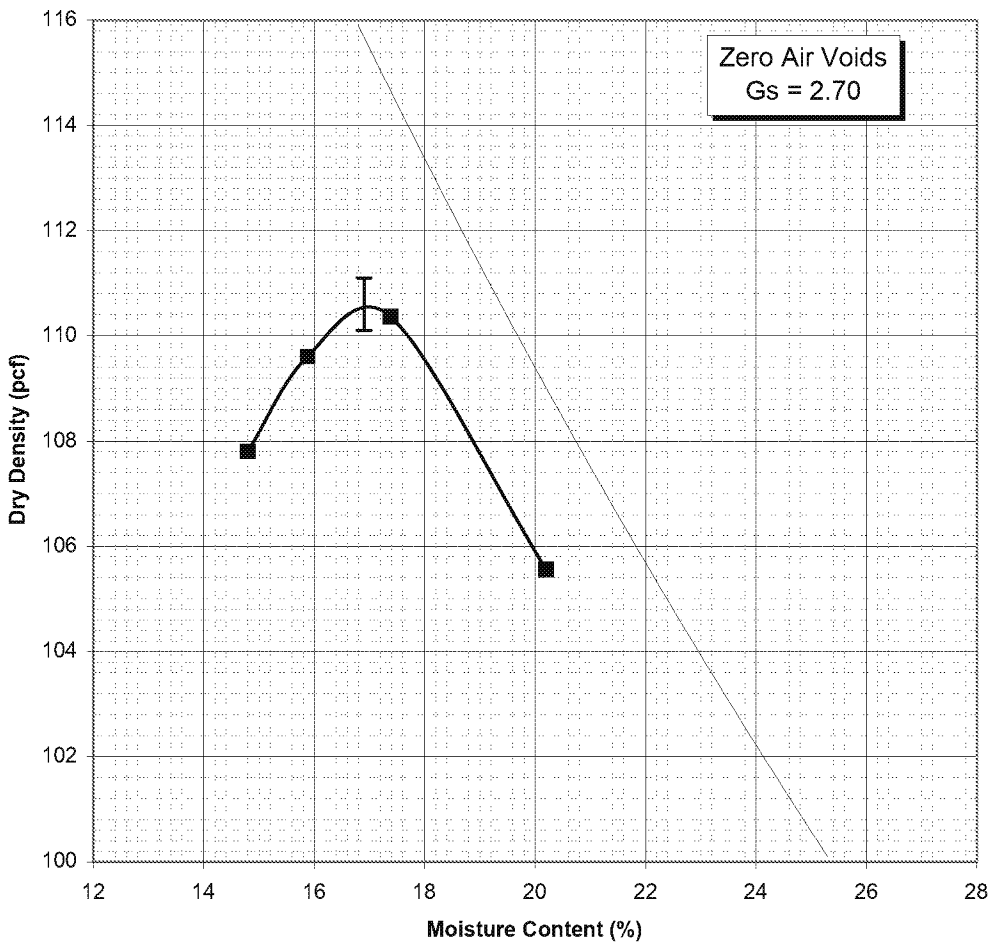
Maximum Dry Density 113.0 PCF
Optimum Moisture Content 15.8 %

LANDFILL RUNOFF COLLECTION POND

Moisture-Density Data Sheet

Project: AEP - Clifty Creek - South Fly Ash Pond
Project No.: 175539022
Source: B-7, 7.0'
Sample No.: 321
Sample Description: brown lean clay, moist
Nmc: 20.5 %
Visual Notes: N/A
Test Method: ASTM D 698 - Method A
Prepared: Dry   Oversized Fraction: < 5 %   Rammer: Mechanical
Gs - Fines: Assumed

Mold Weight 2041 grams		Moisture Determination				
Wet Weight plus Mold (grams)	Wet Weight minus Mold (grams)	Wet Soil and Can Weight (grams)	Dry Soil and Can Weight (grams)	Can Weight (grams)	Water Content (%)	Dry Density (pcf)
3899	1858	421.72	374.30	53.84	14.8	107.8
3948	1907	420.48	370.25	54.04	15.9	109.6
3986	1945	425.03	373.25	75.37	17.4	110.4
3946	1905	465.82	400.33	76.15	20.2	105.6



Maximum Dry Density 110.6 PCF
Optimum Moisture Content 16.9 %

APPENDIX H

LIQUEFACTION ANALYSIS

BOILER SLAG POND DAM: 2015 CCR MANDATE

FINE-GRAINED ANALYSIS

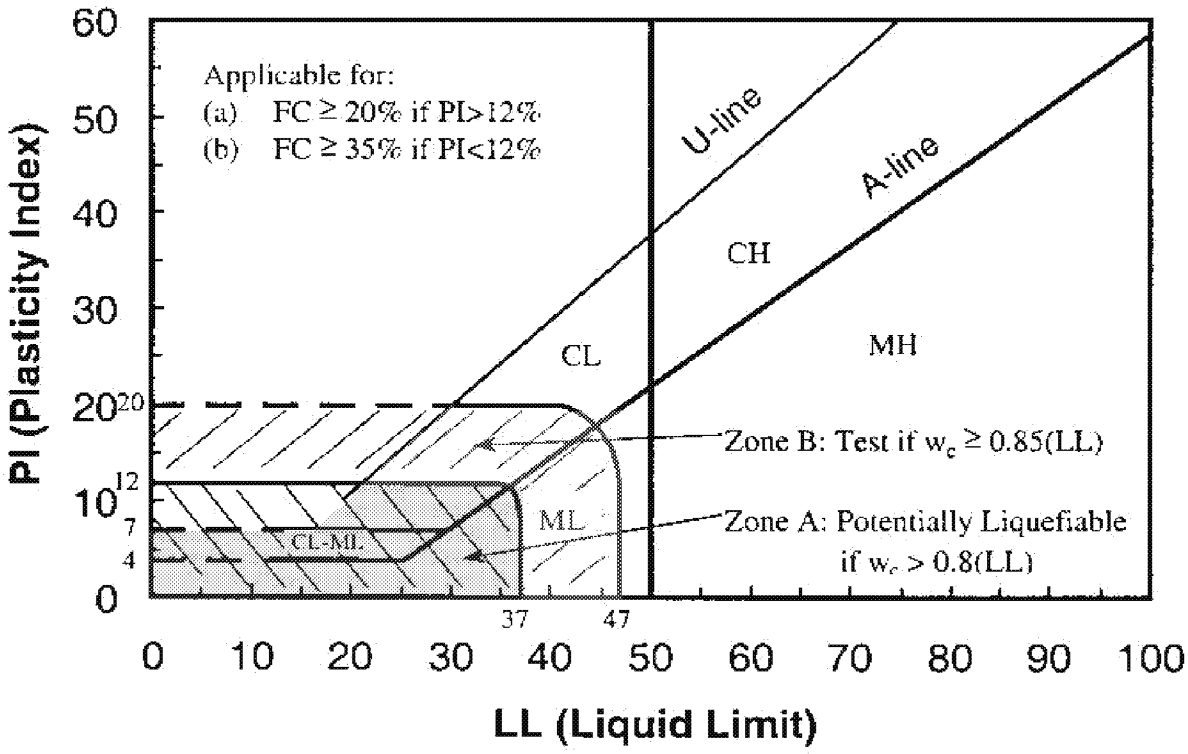
Liquefaction Susceptibility of Fine-Grained Soils

Stantec Project Number:	175553022
Project Name:	AEP Clifty Creek
Site/Structure Name:	West Bottom Ash Dam

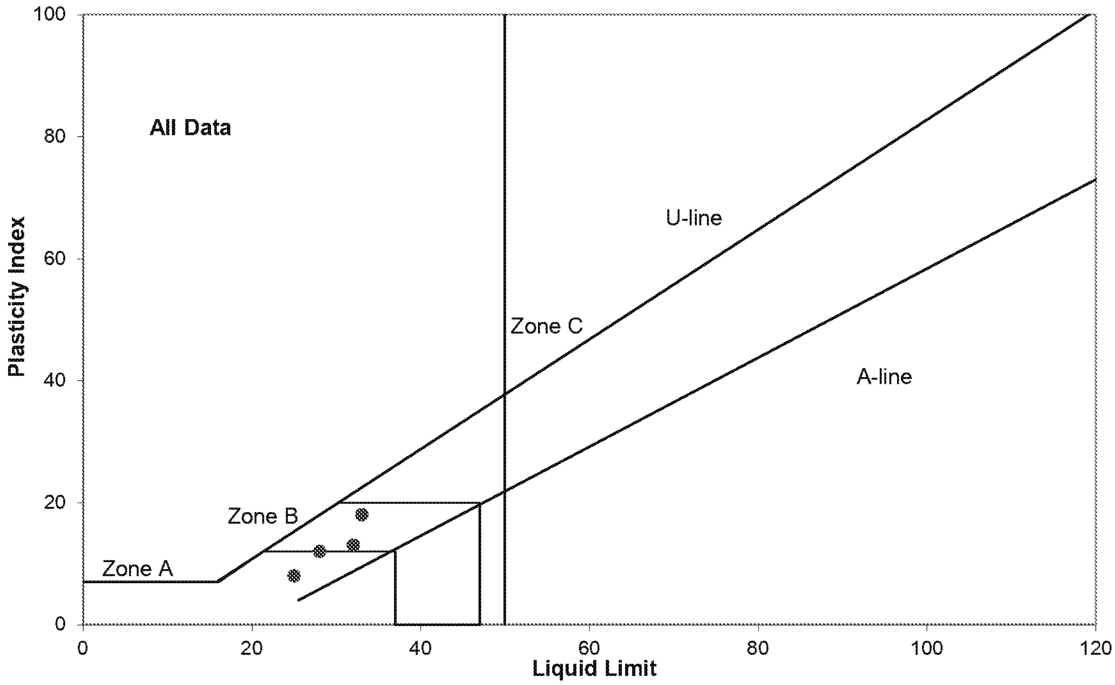
Note: NP = Non-Plastic

Sand-like versus Clay-like Behavior (-1 indicates result does not meet criteria, green shading indicates result does meet criteria, no results shown for non-plastic material)

									Using Criteria published by Seed et al (2003)						Using Criteria published by Idriss and Boulanger (2008)		Using criteria published by MSHA (2010)			Overall Judgement based on 3 methods (sand-like or clay-like)
									Meets criteria for sand-like behavior		Meets criteria for clay-like behavior				Meets criteria for sand-like behavior	Meets criteria for clay-like behavior	Meets criteria for sand-like behavior	Meets criteria for clay-like behavior	Borderline soils (treat as sand-like)	
Lab ID	Boring	Depth(s)	Soil Classification	NMC (w_c) (%)	% Passing #200	% Passing #40	LL	PI	LL in Zone A (see plot)	PI in Zone A (see plot)	LL in Zone B (see plot)	PI in Zone B (see plot)	LL in Zone C (see plot)	PI in Zone C (see plot)	PI < 7	PI >= 7	PI <= 7	P40>=35%, P200>=20%, and PI>=10	7 < PI < 10, or does not meet P40 or P200	
4	B-1	10.0-11.5, 12.5-14.0	CL	19.1	84	98.4	32	13	-1	-1	32	13	-1	-1	-1	13	-1	13	-1	Clay-like
20	B-1	47.5-49.0, 50.0-51.5	CL	25.3	84.1	99.7	28	12	28	12	-1	-1	-1	-1	-1	12	-1	12	-1	Clay-like
43	B-2	32.5-34.0, 35.0-36.5	CL	32.1	79.7	98.7	33	18	-1	-1	33	18	-1	-1	-1	18	-1	18	-1	Clay-like
87	B-4	20.0-21.5, 22.5-24.0	CL	26.6	80.7	99.7	25	8	25	8	-1	-1	-1	-1	-1	8	-1	-1	8	Sand-like
103	B-4	57.5-59.0, 60.0-61.5	GW-GM	10.9	5.7	13.6	NP	NP												Sand-like
129	B-5	55.0-56.5, 57.5-59.0	ML	24.9	54	99.9	NP	NP												Sand-like

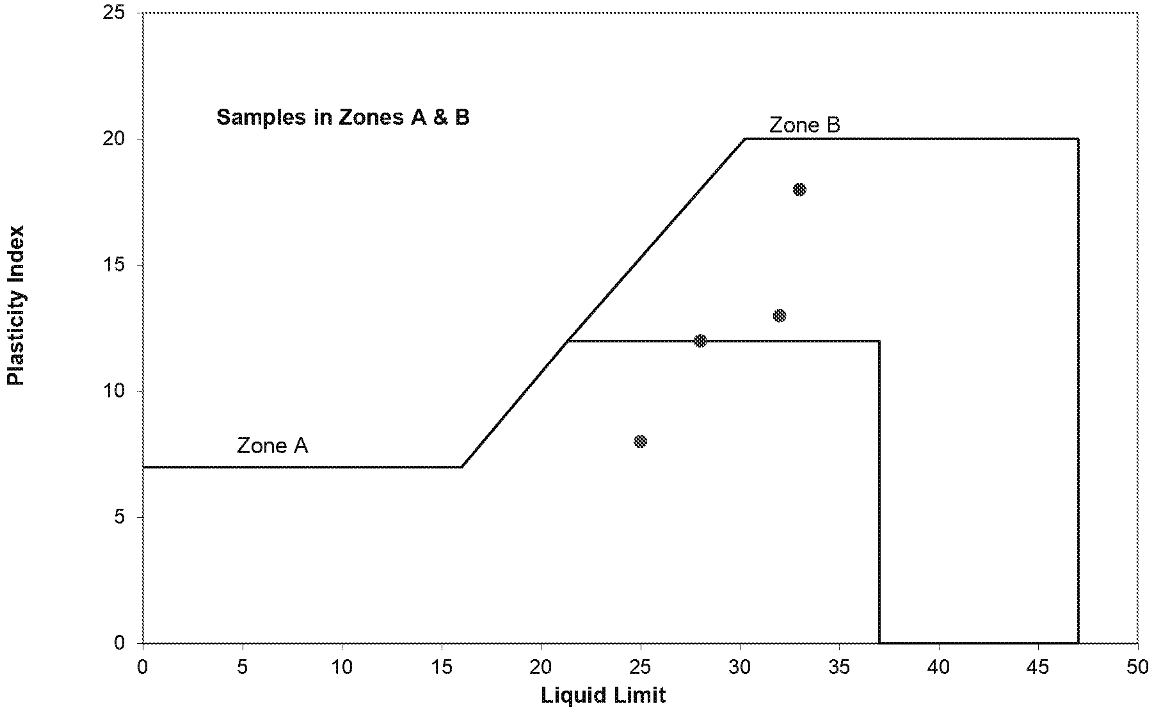


(a)



(b)

Screening Criteria for Liquefiable Fine-Grained Soils (Seed et al. 2003)



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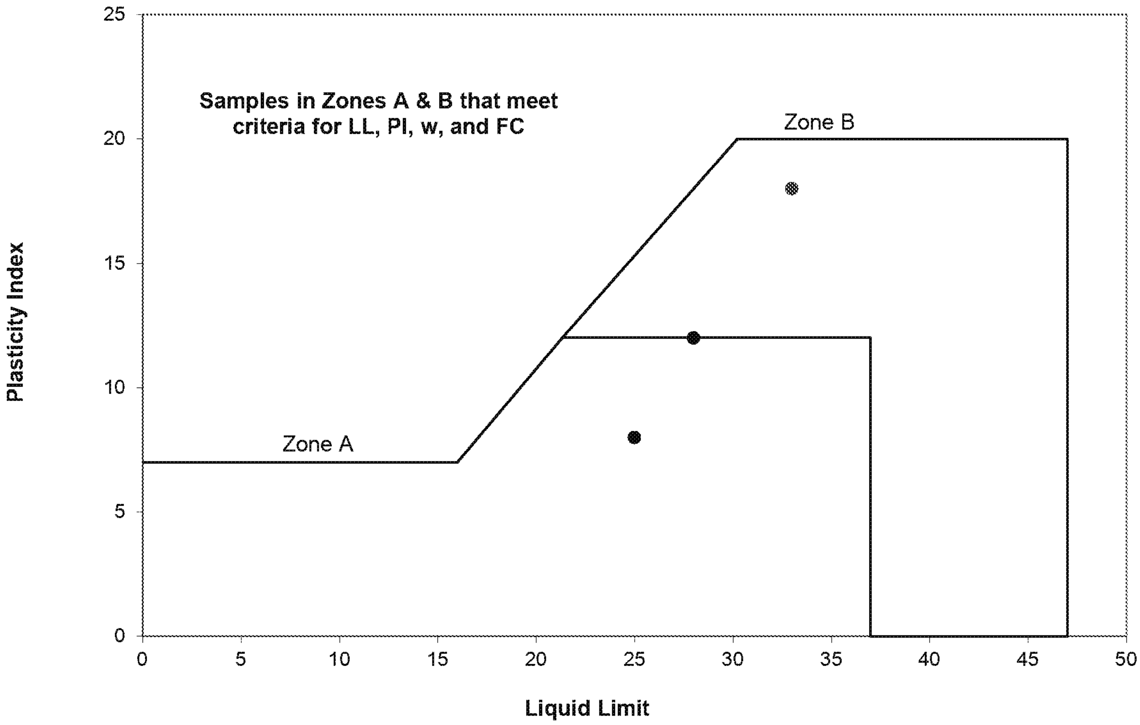
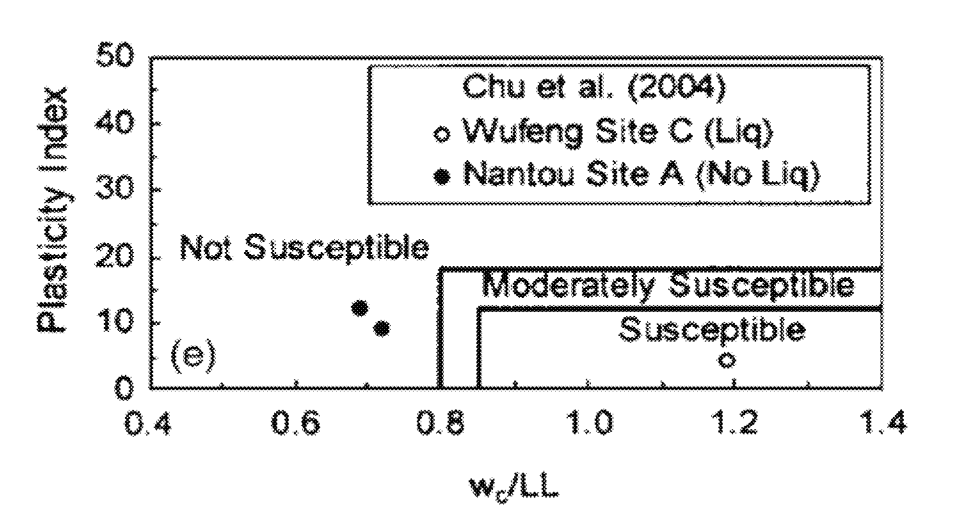
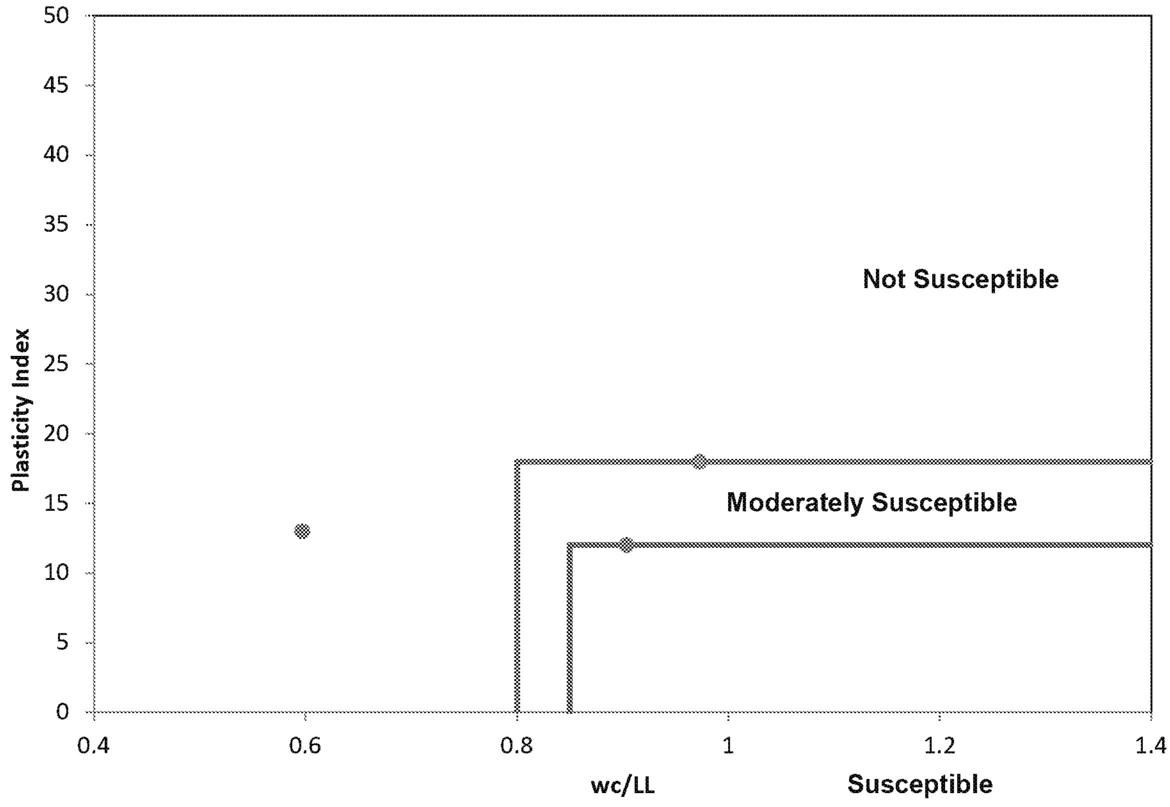


(d)

Screening Criteria for Liquefiable Fine-Grained Soils (Seed et al. 2003)





Screening Criteria for Assessing Liquefaction in Fine Grained Soils (Bray and Sancio 2006)

COARSE-GRAINED ANALYSIS

EQ Source: 0
a max (g): 0.085
EQ Mag (Mw): 7.7

Event (MCE, OBE, etc.): 0
EQ Motion File: 0

Shake Stress Curve Fit Parameters
m4: 0
m3: 0
m2: 0
m1: 0

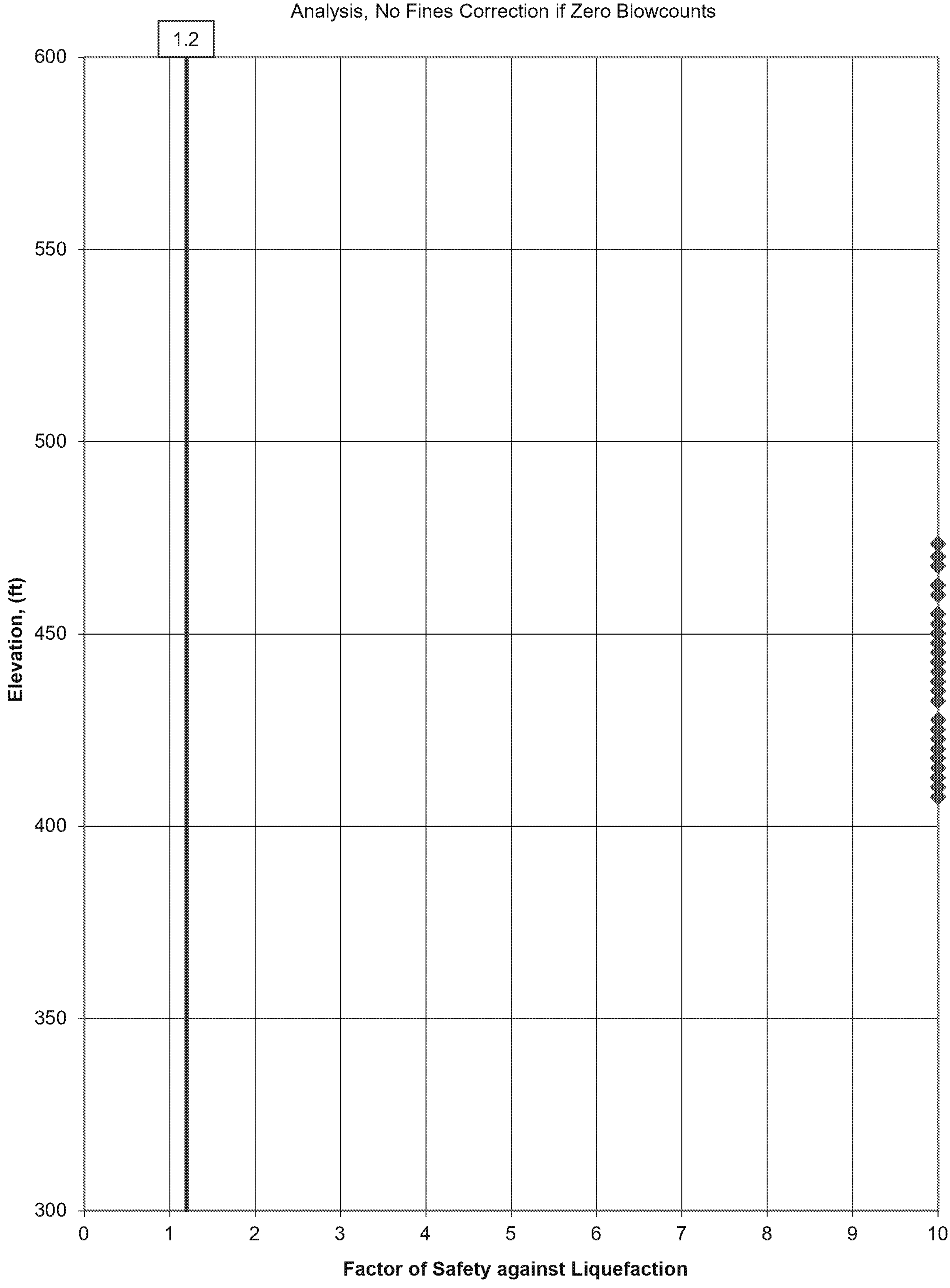
Boring ID: **B-1**
Top of Fill Elevation: 473.4
Fill Height: 0.0
Fill Total Unit Weight: 125
Fill Total Stress: 0.00

Note: A factor of safety shown as "NA" implies that the soil type is not appropriately evaluated using this methodology. This applies to soils classified as CL, CH, CL-ML and MH. These soils should be evaluated using methods for fine-grained soils. Also, "NA" implies that coarse grained soils with equivalent clean sand N-values greater than 30 are resistant to liquefaction.

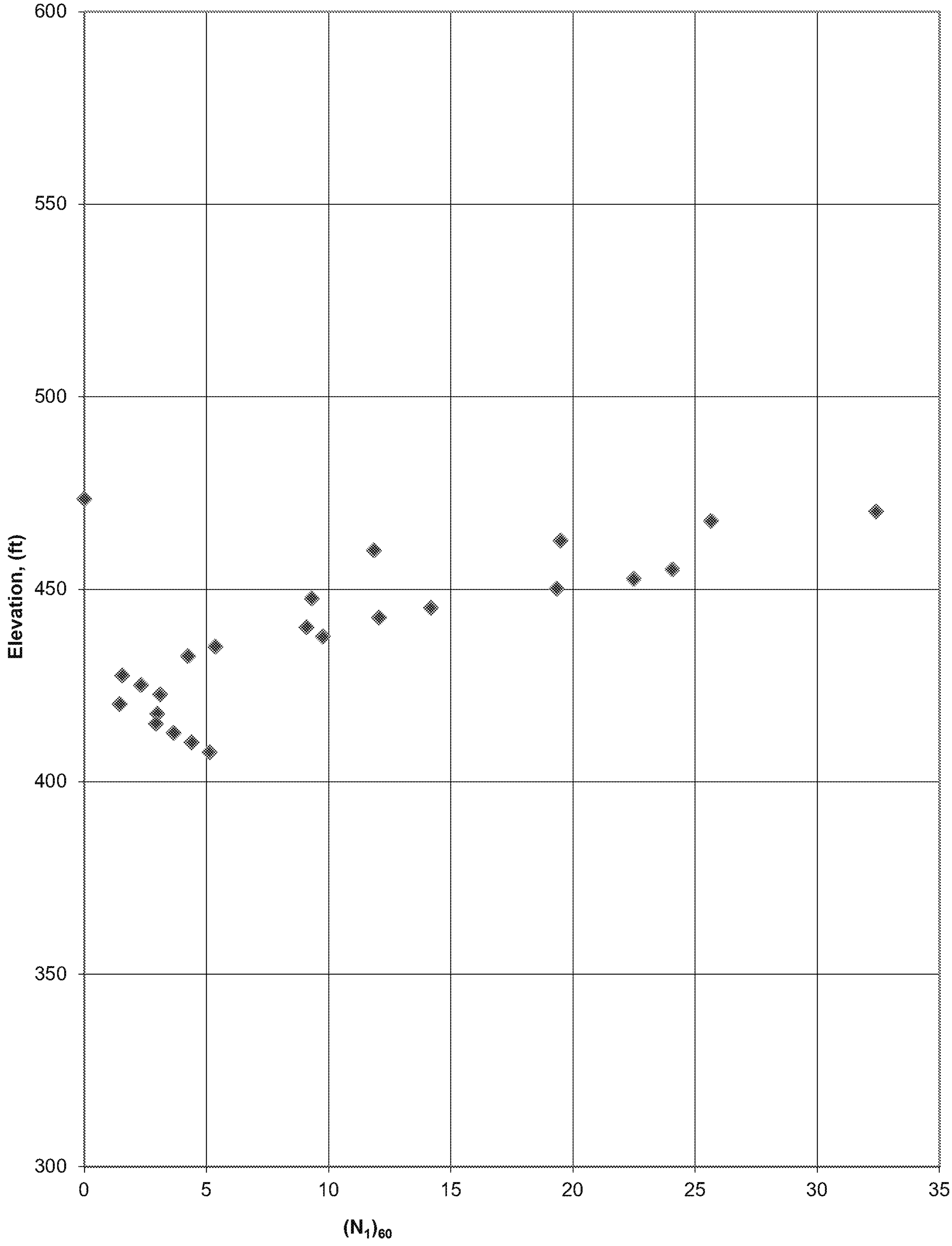
totstr-top: 0.16
u-top: 0.00
effstr-top: 0.16

Depth of Mid. Pt. of Sample (ft.) z	Vert. Total Stress during EQ (tsf) σ_v	Vert. Total Stress during EQ w/ Fill (tsf) $\sigma_{v\ with\ fill}$	Static Pore Pressure during EQ (tsf) u	Vert. Eff. Stress during EQ (tsf) σ'_v	Vert. Eff. Stress during EQ w/ Fill (tsf) $\sigma'_{v\ with\ fill}$	Alpha I	Beta I	Equivalent Clean Sand N-Value $(N_1)_{60cs}$	CRR7.5	Ksigma	Kalpha	Mag. Scaling Factor (Cm)	CRR Design EQ	Simplified Stress Reduction Coeff. r_d	Simplified CSR eq Design EQ	Max. Shake Stress (psf) Design EQ	Avg. Shake Stress (psf) Design EQ	Using SHAKE Data CSR eq Design EQ	Using SHAKE Data FS liq Design EQ	Using SHAKE Data FS liq for plot	Simplified FS liq Design EQ	Simplified FS liq for plot
3.3	0.20	0.20	0.00	0.20	0.20	NA	NA	NA	NA	NA	NA	0.95	NA	0.994	0.055	0	0	0.000	NA	10.0	NA	10.00
5.8	0.36	0.36	0.00	0.36	0.36	NA	NA	NA	NA	NA	NA	0.95	NA	0.989	0.055	0	0	0.000	NA	10.0	NA	10.00
10.8	0.67	0.67	0.00	0.67	0.67	NA	NA	NA	NA	NA	NA	0.95	NA	0.978	0.054	0	0	0.000	NA	10.0	NA	10.00
13.3	0.83	0.83	0.00	0.83	0.83	NA	NA	NA	NA	NA	NA	0.95	NA	0.972	0.054	0	0	0.000	NA	10.0	NA	10.00
18.3	1.14	1.14	0.00	1.14	1.14	NA	NA	NA	NA	NA	NA	0.95	NA	0.961	0.053	0	0	0.000	NA	10.0	NA	10.00
20.8	1.30	1.30	0.00	1.30	1.30	NA	NA	NA	NA	NA	NA	0.95	NA	0.955	0.053	0	0	0.000	NA	10.0	NA	10.00
23.3	1.45	1.45	0.00	1.45	1.45	NA	NA	NA	NA	NA	NA	0.95	NA	0.948	0.052	0	0	0.000	NA	10.0	NA	10.00
25.8	1.61	1.61	0.00	1.61	1.61	NA	NA	NA	NA	NA	NA	0.95	NA	0.939	0.052	0	0	0.000	NA	10.0	NA	10.00
28.3	1.77	1.77	0.00	1.77	1.77	NA	NA	NA	NA	NA	NA	0.95	NA	0.929	0.051	0	0	0.000	NA	10.0	NA	10.00
30.8	1.92	1.92	0.00	1.92	1.92	NA	NA	NA	NA	NA	NA	0.95	NA	0.917	0.051	0	0	0.000	NA	10.0	NA	10.00
33.3	2.08	2.08	0.00	2.08	2.08	NA	NA	NA	NA	NA	NA	0.95	NA	0.902	0.050	0	0	0.000	NA	10.0	NA	10.00
35.8	2.23	2.23	0.00	2.23	2.23	NA	NA	NA	NA	NA	NA	0.95	NA	0.885	0.049	0	0	0.000	NA	10.0	NA	10.00
38.3	2.39	2.39	0.04	2.35	2.35	NA	NA	NA	NA	NA	NA	0.95	NA	0.866	0.049	0	0	0.000	NA	10.0	NA	10.00
40.8	2.55	2.55	0.12	2.43	2.43	NA	NA	NA	NA	NA	NA	0.95	NA	0.844	0.049	0	0	0.000	NA	10.0	NA	10.00
45.8	2.86	2.86	0.27	2.59	2.59	NA	NA	NA	NA	NA	NA	0.95	NA	0.796	0.049	0	0	0.000	NA	10.0	NA	10.00
48.3	3.02	3.02	0.35	2.66	2.66	NA	NA	NA	NA	NA	NA	0.95	NA	0.771	0.048	0	0	0.000	NA	10.0	NA	10.00
50.8	3.17	3.17	0.43	2.74	2.74	NA	NA	NA	NA	NA	NA	0.95	NA	0.745	0.048	0	0	0.000	NA	10.0	NA	10.00
53.3	3.33	3.33	0.51	2.82	2.82	NA	NA	NA	NA	NA	NA	0.95	NA	0.720	0.047	0	0	0.000	NA	10.0	NA	10.00
55.8	3.48	3.48	0.59	2.90	2.90	NA	NA	NA	NA	NA	NA	0.95	NA	0.696	0.046	0	0	0.000	NA	10.0	NA	10.00
58.3	3.64	3.64	0.66	2.98	2.98	NA	NA	NA	NA	NA	NA	0.95	NA	0.674	0.046	0	0	0.000	NA	10.0	NA	10.00
60.8	3.80	3.80	0.74	3.06	3.06	NA	NA	NA	NA	NA	NA	0.95	NA	0.653	0.045	0	0	0.000	NA	10.0	NA	10.00
63.3	3.95	3.95	0.82	3.13	3.13	NA	NA	NA	NA	NA	NA	0.95	NA	0.634	0.044	0	0	0.000	NA	10.0	NA	10.00
65.8	4.11	4.11	0.90	3.21	3.21	NA	NA	NA	NA	NA	NA	0.95	NA	0.617	0.044	0	0	0.000	NA	10.0	NA	10.00

Clifty Creek AEP, Boring = B-1, Source = 0, Mw = 7.7, Event = 0, SPT Data, NCEER Method (updated per Idriss and Boulanger (2008)) with Ground Response Analysis, No Fines Correction if Zero Blowcounts



Clifty Creek AEP, Boring = B-1, Source = 0, Mw = 7.7, Event = 0, SPT Data, NCEER Method (updated per Idriss and Boulanger (2008)) with Ground Response Analysis, No Fines Correction if Zero Blowcounts



EQ Source: 0
a max (g): 0.085
EQ Mag (Mw): 7.7

Event (MCE, OBE, etc.): 0
EQ Motion File: 0

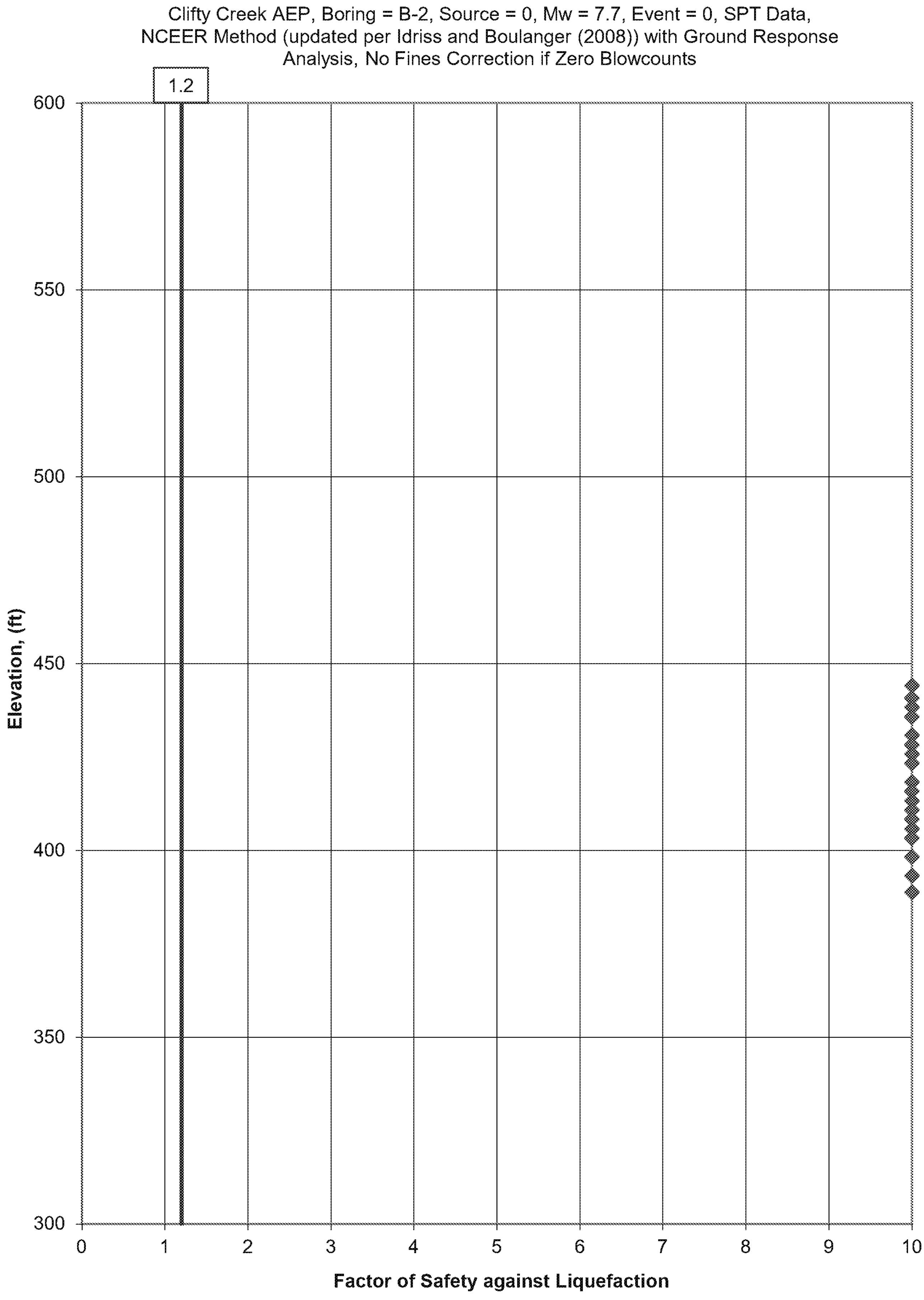
Shake Stress Curve Fit Parameters
m4: 0
m3: 0
m2: 0
m1: 0

Boring ID: **B-2**
Top of Fill Elevation: 444.0
Fill Height: 0.0
Fill Total Unit Weight: 125
Fill Total Stress: 0.00

Note: A factor of safety shown as "NA" implies that the soil type is not appropriately evaluated using this methodology. This applies to soils classified as CL, CH, CL-ML and MH. These soils should be evaluated using methods for fine-grained soils. Also, "NA" implies that coarse grained soils with equivalent clean sand N-values greater than 30 are resistant to liquefaction.

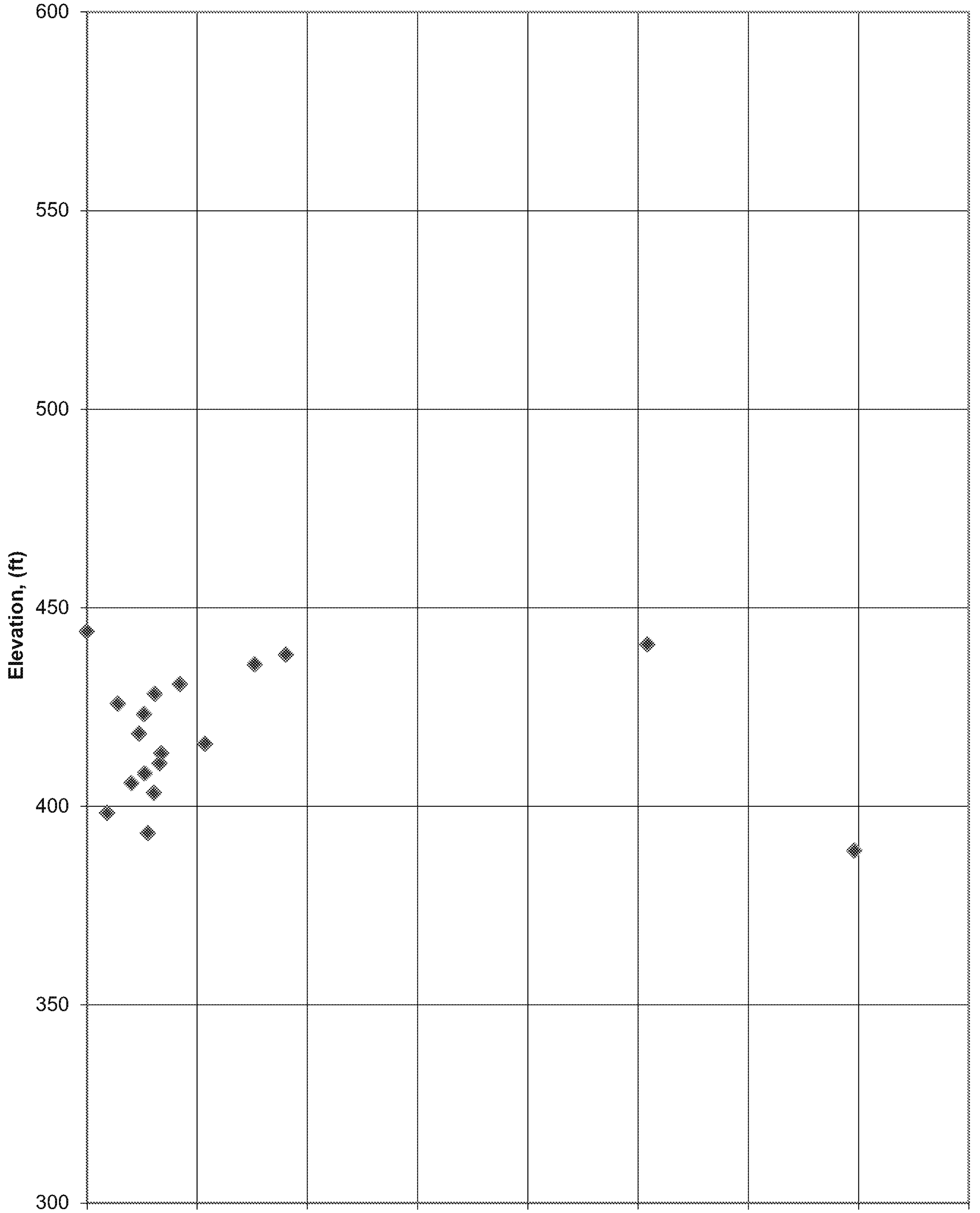
totstr-top: 0.16
u-top: 0.00
effstr-top: 0.16

Depth of Mid. Pt. of Sample (ft.) z	Vert. Total Stress during EQ (tsf) σ_v	Vert. Total Stress during EQ w/ Fill (tsf) $\sigma_{v\ with\ fill}$	Static Pore Pressure during EQ (tsf) u	Vert. Eff. Stress during EQ (tsf) σ'_v	Vert. Eff. Stress during EQ w/ Fill (tsf) $\sigma'_{v\ with\ fill}$	Alpha I	Beta I	Equivalent Clean Sand N-Value $(N_1)_{60cs}$	CRR7.5	Ksigma	Kalpha	Mag. Scaling Factor (Cm)	CRR Design EQ	Simplified Stress Reduction Coeff., r_d	Simplified CSR eq Design EQ	Max. Shake Stress (psf) Design EQ	Avg. Shake Stress (psf) Design EQ	Using SHAKE Data CSR eq Design EQ	Using SHAKE Data FS liq Design EQ	Using SHAKE Data FS liq for plot	Simplified FS liq Design EQ	Simplified FS liq for plot
3.3	0.20	0.20	0.00	0.20	0.20	NA	NA	NA	NA	NA	NA	0.95	NA	0.994	0.055	0	0	0.000	NA	10.0	NA	10.0
5.8	0.36	0.36	0.00	0.36	0.36	NA	NA	NA	NA	NA	NA	0.95	NA	0.989	0.055	0	0	0.000	NA	10.0	NA	10.0
8.3	0.52	0.52	0.00	0.52	0.52	NA	NA	NA	NA	NA	NA	0.95	NA	0.983	0.054	0	0	0.000	NA	10.0	NA	10.0
13.3	0.83	0.83	0.00	0.83	0.83	NA	NA	NA	NA	NA	NA	0.95	NA	0.972	0.054	0	0	0.000	NA	10.0	NA	10.0
15.8	0.98	0.98	0.02	0.96	0.96	NA	NA	NA	NA	NA	NA	0.95	NA	0.967	0.055	0	0	0.000	NA	10.0	NA	10.0
18.3	1.14	1.14	0.10	1.04	1.04	NA	NA	NA	NA	NA	NA	0.95	NA	0.961	0.058	0	0	0.000	NA	10.0	NA	10.0
20.8	1.30	1.30	0.18	1.12	1.12	NA	NA	NA	NA	NA	NA	0.95	NA	0.955	0.061	0	0	0.000	NA	10.0	NA	10.0
25.8	1.61	1.61	0.34	1.27	1.27	NA	NA	NA	NA	NA	NA	0.95	NA	0.939	0.066	0	0	0.000	NA	10.0	NA	10.0
28.3	1.77	1.77	0.41	1.35	1.35	NA	NA	NA	NA	NA	NA	0.95	NA	0.929	0.067	0	0	0.000	NA	10.0	NA	10.0
30.8	1.92	1.92	0.49	1.43	1.43	NA	NA	NA	NA	NA	NA	0.95	NA	0.917	0.068	0	0	0.000	NA	10.0	NA	10.0
33.3	2.08	2.08	0.57	1.51	1.51	NA	NA	NA	NA	NA	NA	0.95	NA	0.902	0.069	0	0	0.000	NA	10.0	NA	10.0
35.8	2.23	2.23	0.65	1.59	1.59	NA	NA	NA	NA	NA	NA	0.95	NA	0.885	0.069	0	0	0.000	NA	10.0	NA	10.0
38.3	2.39	2.39	0.73	1.67	1.67	NA	NA	NA	NA	NA	NA	0.95	NA	0.866	0.069	0	0	0.000	NA	10.0	NA	10.0
40.8	2.55	2.55	0.80	1.74	1.74	NA	NA	NA	NA	NA	NA	0.95	NA	0.844	0.068	0	0	0.000	NA	10.0	NA	10.0
45.8	2.86	2.86	0.96	1.90	1.90	NA	NA	NA	NA	NA	NA	0.95	NA	0.796	0.066	0	0	0.000	NA	10.0	NA	10.0
50.8	3.17	3.17	1.12	2.06	2.06	NA	NA	NA	NA	NA	NA	0.95	NA	0.745	0.063	0	0	0.000	NA	10.0	NA	10.0
55.3	3.45	3.45	1.26	2.20	2.20	0.02	1.00	70	NA	0.781	1.000	0.95	NA	0.701	0.061	0	0	0.000	NA	10.0	NA	10.0



Clifty Creek AEP, Boring = B-2, Source = 0, Mw = 7.7, Event = 0, SPT Data, NCEER Method (updated per Idriss and Boulanger (2008)) with Ground Response Analysis, No Fines Correction if Zero Blowcounts
1.2
600
550
500
450
400
350
300
Elevation, (ft)
0
1
2
3
4
5
6
7
8
9
10
Factor of Safety against Liquefaction

Clifty Creek AEP, Boring = B-2, Source = 0, Mw = 7.7, Event = 0, SPT Data, NCEER Method (updated per Idriss and Boulanger (2008)) with Ground Response Analysis, No Fines Correction if Zero Blowcounts



EQ Source	0
a max (g)	0.085
EQ Mag (Mw)	7.7

Event (MCE, OBE, etc.)	0
EQ Motion File	0

Shake Stress Curve Fit Parameters	
m4:	0
m3:	0
m2:	0
m1:	0

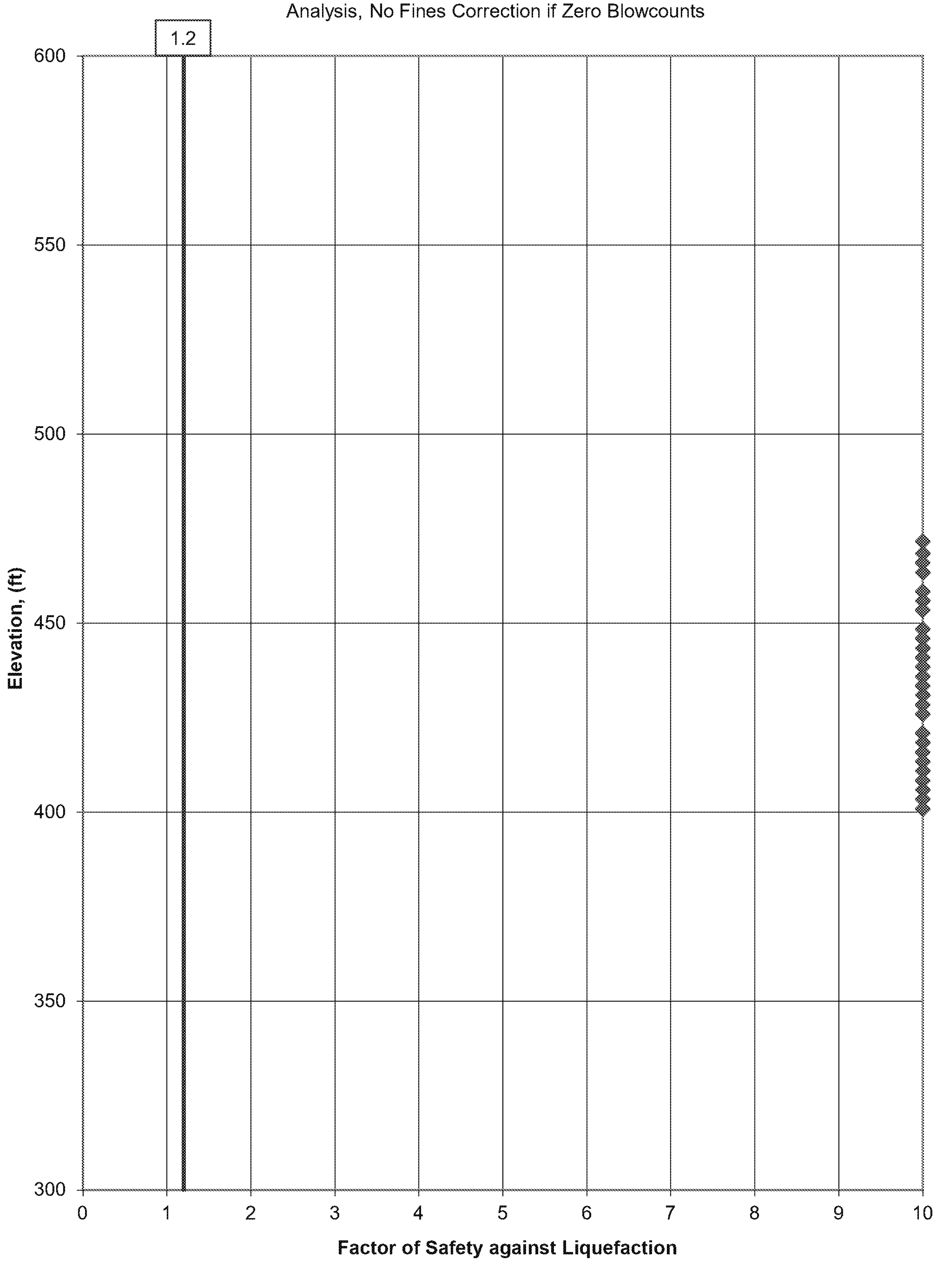
Boring ID:	B-3
Top of Fill Elevation:	471.6
Fill Height:	0.0
Fill Total Unit Weight:	125
Fill Total Stress:	0.00

Note: A factor of safety shown as "NA" implies that the soil type is not appropriately evaluated using this methodology. This applies to soils classified as CL, CH, CL-ML and MH. These soils should be evaluated using methods for fine-grained soils. Also, "NA" implies that coarse grained soils with equivalent clean sand N-values greater than 30 are resistant to liquefaction.

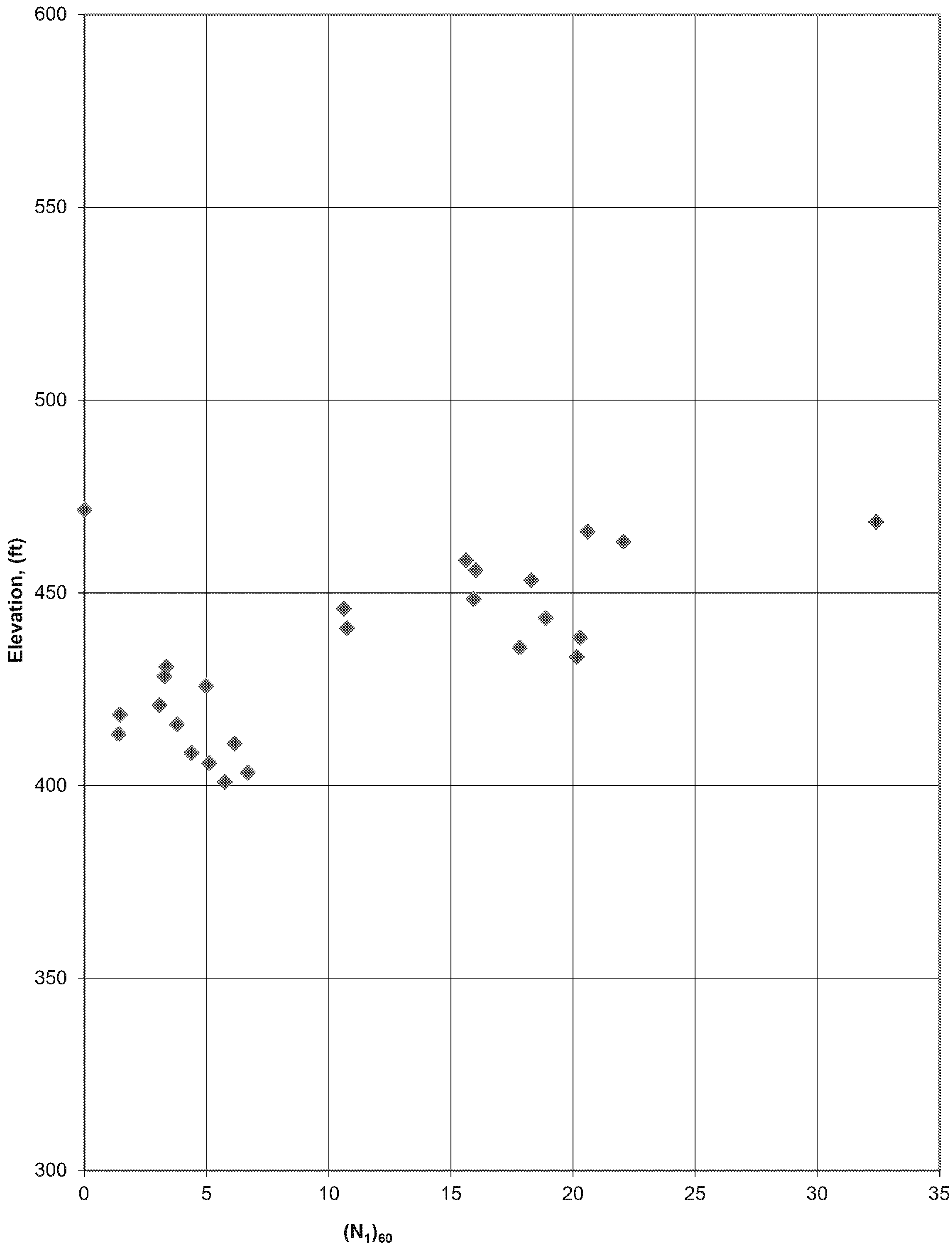
totstr-top	u-top	effstr-top
0.16	0.00	0.16

Depth of Mid. Pt. of Sample (ft.) z	Vert. Total Stress during EQ (tsf) σ_v	Vert. Total Stress during EQ w/ Fill (tsf) $\sigma_{v\ with\ fill}$	Static Pore Pressure during EQ (tsf) u	Vert. Eff. Stress during EQ (tsf) σ'_v	Vert. Eff. Stress during EQ w/ Fill (tsf) $\sigma'_{v\ with\ fill}$	Alpha I	Beta I	Equivalent Clean Sand N-Value $(N_1)_{60cs}$	CRR7.5	Ksigma	Kalpha	Mag. Scaling Factor (Cm)	CRR Design EQ	Simplified Stress Reduction Coeff., r_d	Simplified CSR eq Design EQ	Max. Shake Stress (psf) Design EQ	Avg. Shake Stress (psf) Design EQ	Using SHAKE Data CSR eq Design EQ	Using SHAKE Data FS liq Design EQ	Using SHAKE Data FS liq for plot	Simplified FS liq Design EQ	Simplified FS liq for plot
3.3	0.20	0.20	0.00	0.20	0.20	NA	NA	NA	NA	NA	NA	0.95	NA	0.994	0.055	0	0	0.000	NA	10.0	NA	10.00
5.8	0.36	0.36	0.00	0.36	0.36	NA	NA	NA	NA	NA	NA	0.95	NA	0.989	0.055	0	0	0.000	NA	10.0	NA	10.00
8.3	0.52	0.52	0.00	0.52	0.52	NA	NA	NA	NA	NA	NA	0.95	NA	0.983	0.054	0	0	0.000	NA	10.0	NA	10.00
13.3	0.83	0.83	0.00	0.83	0.83	NA	NA	NA	NA	NA	NA	0.95	NA	0.972	0.054	0	0	0.000	NA	10.0	NA	10.00
15.8	0.98	0.98	0.00	0.98	0.98	NA	NA	NA	NA	NA	NA	0.95	NA	0.967	0.053	0	0	0.000	NA	10.0	NA	10.00
18.3	1.14	1.14	0.00	1.14	1.14	NA	NA	NA	NA	NA	NA	0.95	NA	0.961	0.053	0	0	0.000	NA	10.0	NA	10.00
23.3	1.45	1.45	0.00	1.45	1.45	NA	NA	NA	NA	NA	NA	0.95	NA	0.948	0.052	0	0	0.000	NA	10.0	NA	10.00
25.8	1.61	1.61	0.00	1.61	1.61	NA	NA	NA	NA	NA	NA	0.95	NA	0.939	0.052	0	0	0.000	NA	10.0	NA	10.00
28.3	1.77	1.77	0.00	1.77	1.77	NA	NA	NA	NA	NA	NA	0.95	NA	0.929	0.051	0	0	0.000	NA	10.0	NA	10.00
30.8	1.92	1.92	0.00	1.92	1.92	NA	NA	NA	NA	NA	NA	0.95	NA	0.917	0.051	0	0	0.000	NA	10.0	NA	10.00
33.3	2.08	2.08	0.00	2.08	2.08	NA	NA	NA	NA	NA	NA	0.95	NA	0.902	0.050	0	0	0.000	NA	10.0	NA	10.00
35.8	2.23	2.23	0.00	2.23	2.23	NA	NA	NA	NA	NA	NA	0.95	NA	0.885	0.049	0	0	0.000	NA	10.0	NA	10.00
38.3	2.39	2.39	0.07	2.32	2.32	NA	NA	NA	NA	NA	NA	0.95	NA	0.866	0.049	0	0	0.000	NA	10.0	NA	10.00
40.8	2.55	2.55	0.15	2.40	2.40	NA	NA	NA	NA	NA	NA	0.95	NA	0.844	0.050	0	0	0.000	NA	10.0	NA	10.00
43.3	2.70	2.70	0.23	2.48	2.48	NA	NA	NA	NA	NA	NA	0.95	NA	0.821	0.049	0	0	0.000	NA	10.0	NA	10.00
45.8	2.86	2.86	0.30	2.56	2.56	NA	NA	NA	NA	NA	NA	0.95	NA	0.796	0.049	0	0	0.000	NA	10.0	NA	10.00
50.8	3.17	3.17	0.46	2.71	2.71	NA	NA	NA	NA	NA	NA	0.95	NA	0.745	0.048	0	0	0.000	NA	10.0	NA	10.00
53.3	3.33	3.33	0.54	2.79	2.79	NA	NA	NA	NA	NA	NA	0.95	NA	0.720	0.047	0	0	0.000	NA	10.0	NA	10.00
55.8	3.48	3.48	0.62	2.87	2.87	NA	NA	NA	NA	NA	NA	0.95	NA	0.696	0.047	0	0	0.000	NA	10.0	NA	10.00
58.3	3.64	3.64	0.69	2.95	2.95	NA	NA	NA	NA	NA	NA	0.95	NA	0.674	0.046	0	0	0.000	NA	10.0	NA	10.00
60.8	3.80	3.80	0.77	3.02	3.02	NA	NA	NA	NA	NA	NA	0.95	NA	0.653	0.045	0	0	0.000	NA	10.0	NA	10.00
63.3	3.95	3.95	0.85	3.10	3.10	NA	NA	NA	NA	NA	NA	0.95	NA	0.634	0.045	0	0	0.000	NA	10.0	NA	10.00
65.8	4.11	4.11	0.93	3.18	3.18	NA	NA	NA	NA	NA	NA	0.95	NA	0.617	0.044	0	0	0.000	NA	10.0	NA	10.00
68.3	4.27	4.27	1.01	3.26	3.26	NA	NA	NA	NA	NA	NA	0.95	NA	0.602	0.044	0	0	0.000	NA	10.0	NA	10.00
70.8	4.42	4.42	1.08	3.34	3.34	NA	NA	NA	NA	NA	NA	0.95	NA	0.588	0.043	0	0	0.000	NA	10.0	NA	10.00

Clifty Creek AEP, Boring = B-3, Source = 0, Mw = 7.7, Event = 0, SPT Data, NCEER Method (updated per Idriss and Boulanger (2008)) with Ground Response Analysis, No Fines Correction if Zero Blowcounts



Clifty Creek AEP, Boring = B-3, Source = 0, Mw = 7.7, Event = 0, SPT Data, NCEER Method (updated per Idriss and Boulanger (2008)) with Ground Response Analysis, No Fines Correction if Zero Blowcounts



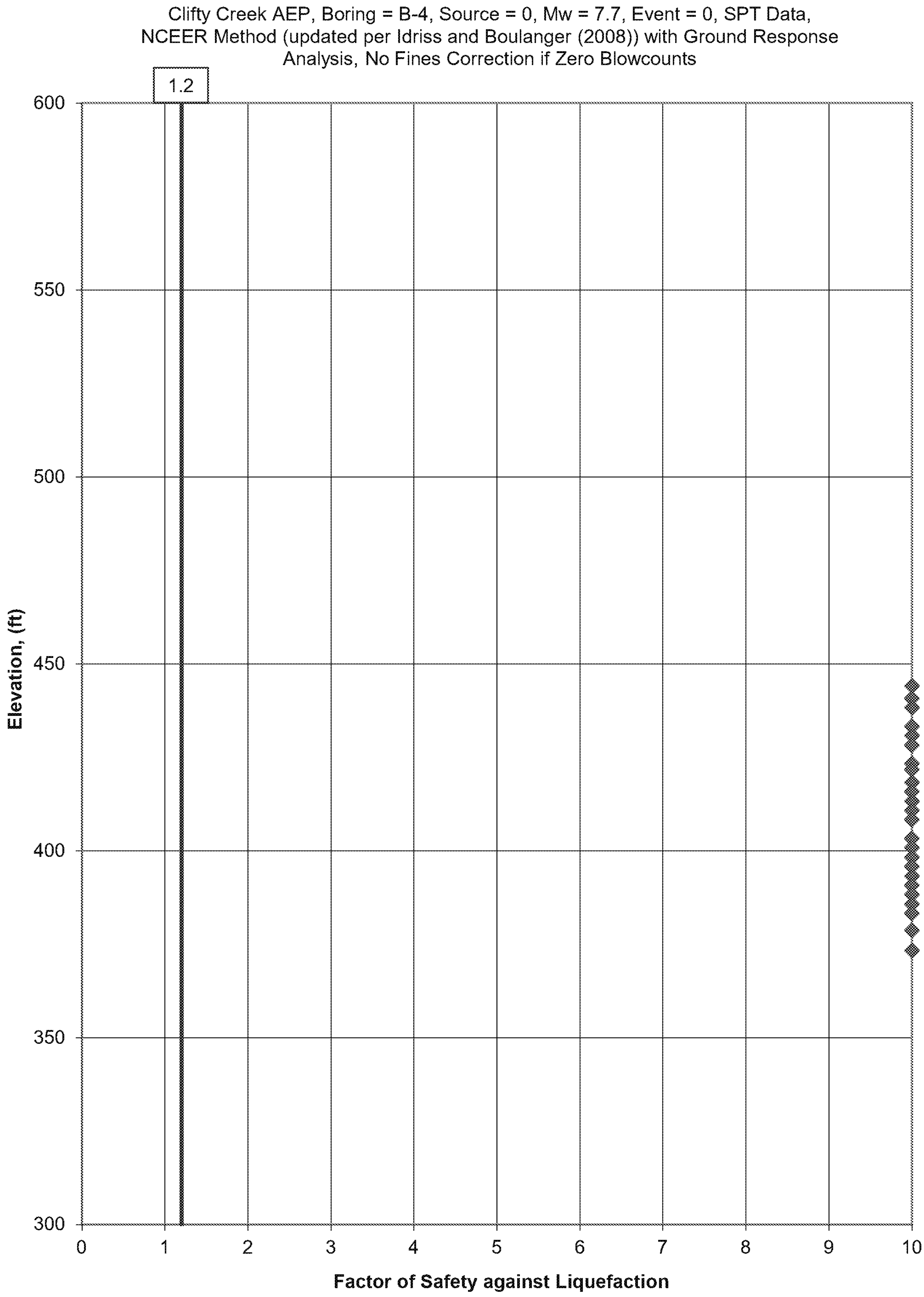
EQ Source	a max (g)	EQ Mag (Mw)	Event (MCE, OBE, etc.)	EQ Motion File
0	0.085	7.7	0	0

Shake Stress Curve Fit Parameters	
m4:	0
m3:	0
m2:	0
m1:	0

Boring ID:	**B-4**
Top of Fill Elevation:	444.0
Fill Height:	0.0
Fill Total Unit Weight:	125
Fill Total Stress:	0.00

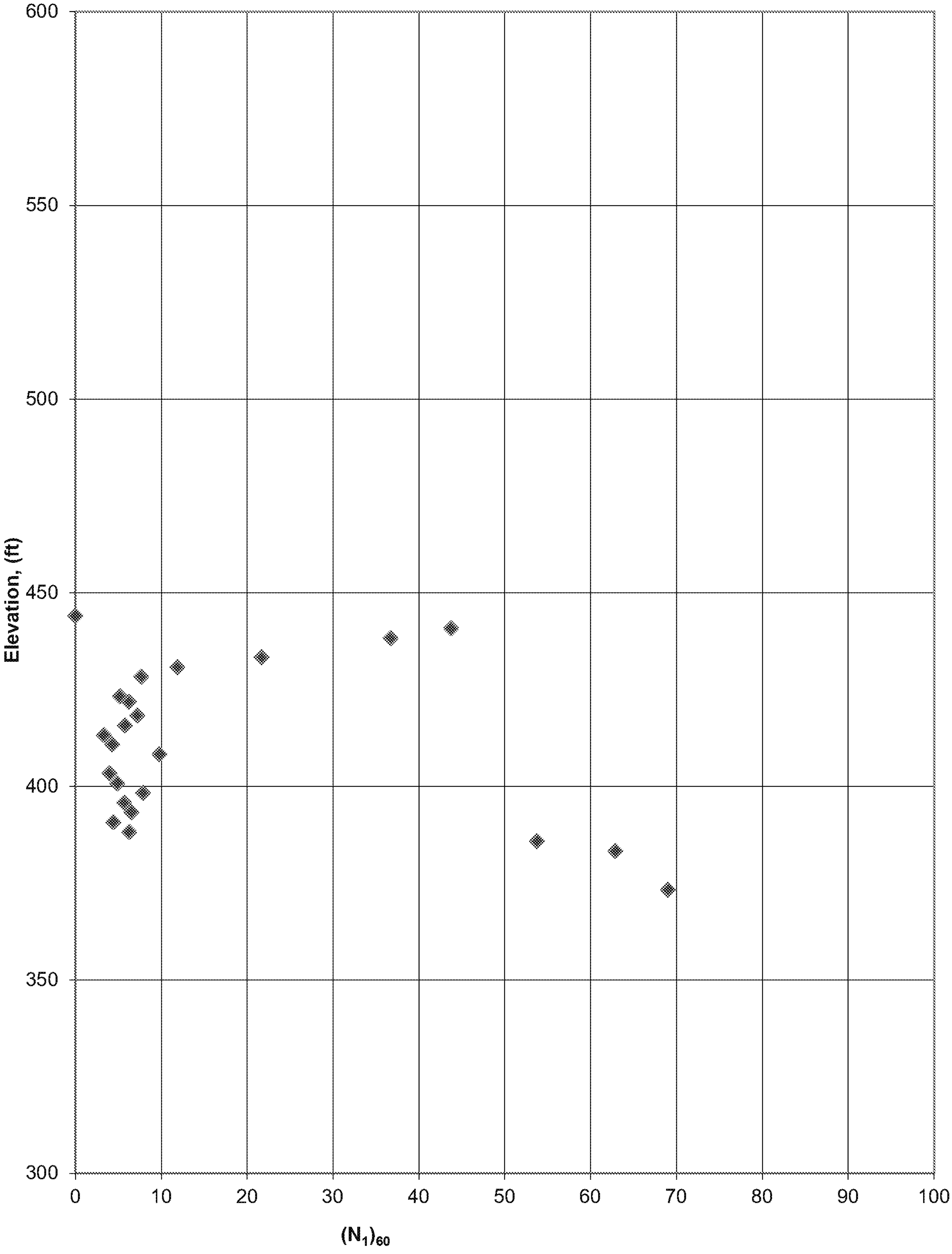
Note: A factor of safety shown as "NA" implies that the soil type is not appropriately evaluated using this methodology. This applies to soils classified as CL, CH, CL-ML and MH. These soils should be evaluated using methods for fine-grained soils. Also, "NA" implies that coarse grained soils with equivalent clean sand N-values greater than 30 are resistant to liquefaction.

Depth of Mid. Pt. of Sample (ft.) z	Vert. Total Stress during EQ (tsf) σ_v	Vert. Total Stress during EQ w/ Fill (tsf) $\sigma_{v\ with\ fill}$	Static Pore Pressure during EQ (tsf) u	Vert. Eff. Stress during EQ (tsf) σ'_v	Vert. Eff. Stress during EQ w/ Fill (tsf) $\sigma'_{v\ with\ fill}$	Alpha I	Beta I	Equivalent Clean Sand N-Value $(N_1)_{60cs}$	CRR7.5	Ksigma	Kalpha	Mag. Scaling Factor (Cm)	CRR Design EQ	Simplified Stress Reduction Coeff., r_d	Simplified CSR eq Design EQ	Max. Shake Stress (psf) Design EQ	Avg. Shake Stress (psf) Design EQ	Using SHAKE Data CSR eq Design EQ	Using SHAKE Data FS liq Design EQ	Using SHAKE Data FS liq for plot	Simplified FS liq Design EQ	Simplified FS liq for plot
	totstr-top 0.16		u-top 0.00	effstr-top 0.16																		
3.3	0.20	0.20	0.00	0.20	0.20	NA	NA	NA	NA	NA	NA	0.95	NA	0.994	0.055	0	0	0.000	NA	10.0	NA	10.00
5.8	0.36	0.36	0.00	0.36	0.36	NA	NA	NA	NA	NA	NA	0.95	NA	0.989	0.055	0	0	0.000	NA	10.0	NA	10.00
10.8	0.67	0.67	0.00	0.67	0.67	NA	NA	NA	NA	NA	NA	0.95	NA	0.978	0.054	0	0	0.000	NA	10.0	NA	10.00
13.3	0.83	0.83	0.00	0.83	0.83	NA	NA	NA	NA	NA	NA	0.95	NA	0.972	0.054	0	0	0.000	NA	10.0	NA	10.00
15.8	0.98	0.98	0.00	0.98	0.98	NA	NA	NA	NA	NA	NA	0.95	NA	0.967	0.053	0	0	0.000	NA	10.0	NA	10.00
20.8	1.30	1.30	0.15	1.15	1.15	NA	NA	NA	NA	NA	NA	0.95	NA	0.955	0.060	0	0	0.000	NA	10.0	NA	10.00
22.3	1.39	1.39	0.20	1.20	1.20	NA	NA	NA	NA	NA	NA	0.95	NA	0.951	0.061	0	0	0.000	NA	10.0	NA	10.00
25.8	1.61	1.61	0.30	1.31	1.31	NA	NA	NA	NA	NA	NA	0.95	NA	0.939	0.064	0	0	0.000	NA	10.0	NA	10.00
28.3	1.77	1.77	0.38	1.38	1.38	NA	NA	NA	NA	NA	NA	0.95	NA	0.929	0.066	0	0	0.000	NA	10.0	NA	10.00
30.8	1.92	1.92	0.46	1.46	1.46	NA	NA	NA	NA	NA	NA	0.95	NA	0.917	0.067	0	0	0.000	NA	10.0	NA	10.00
33.3	2.08	2.08	0.54	1.54	1.54	NA	NA	NA	NA	NA	NA	0.95	NA	0.902	0.067	0	0	0.000	NA	10.0	NA	10.00
35.8	2.23	2.23	0.62	1.62	1.62	NA	NA	NA	NA	NA	NA	0.95	NA	0.885	0.068	0	0	0.000	NA	10.0	NA	10.00
40.8	2.55	2.55	0.77	1.77	1.77	NA	NA	NA	NA	NA	NA	0.95	NA	0.844	0.067	0	0	0.000	NA	10.0	NA	10.00
43.3	2.70	2.70	0.85	1.85	1.85	NA	NA	NA	NA	NA	NA	0.95	NA	0.821	0.066	0	0	0.000	NA	10.0	NA	10.00
45.8	2.86	2.86	0.93	1.93	1.93	NA	NA	NA	NA	NA	NA	0.95	NA	0.796	0.065	0	0	0.000	NA	10.0	NA	10.00
48.3	3.02	3.02	1.01	2.01	2.01	NA	NA	NA	NA	NA	NA	0.95	NA	0.771	0.064	0	0	0.000	NA	10.0	NA	10.00
50.8	3.17	3.17	1.08	2.09	2.09	NA	NA	NA	NA	NA	NA	0.95	NA	0.745	0.063	0	0	0.000	NA	10.0	NA	10.00
53.3	3.33	3.33	1.16	2.17	2.17	NA	NA	NA	NA	NA	NA	0.95	NA	0.720	0.061	0	0	0.000	NA	10.0	NA	10.00
55.8	3.48	3.48	1.24	2.24	2.24	NA	NA	NA	NA	NA	NA	0.95	NA	0.696	0.060	0	0	0.000	NA	10.0	NA	10.00
58.3	3.64	3.64	1.32	2.32	2.32	0.02	1.00	54	NA	0.764	1.000147	0.95	NA	0.674	0.058	0	0	0.000	NA	10.0	NA	10.00
60.8	3.80	3.80	1.40	2.40	2.40	0.02	1.00	63	NA	0.754	1.000147	0.95	NA	0.653	0.057	0	0	0.000	NA	10.0	NA	10.00
65.3	4.08	4.08	1.54	2.54	2.54	0.02	1.00	1354	NA	0.737	1.000147	0.95	NA	0.620	0.055	0	0	0.000	NA	10.0	NA	10.00
70.8	4.42	4.42	1.71	2.71	2.71	0.02	1.00	69	NA	0.717	1.000147	0.95	NA	0.588	0.053	0	0	0.000	NA	10.0	NA	10.00



Clifty Creek AEP, Boring = B-4, Source = 0, Mw = 7.7, Event = 0, SPT Data,
NCEER Method (updated per Idriss and Boulanger (2008)) with Ground Response
Analysis, No Fines Correction if Zero Blowcounts
1.2
600
550
500
450
400
350
300
Elevation, (ft)
0
1
2
3
4
5
6
7
8
9
10
Factor of Safety against Liquefaction

Clifty Creek AEP, Boring = B-4, Source = 0, Mw = 7.7, Event = 0, SPT Data, NCEER Method (updated per Idriss and Boulanger (2008)) with Ground Response Analysis, No Fines Correction if Zero Blowcounts



EQ Source: 0
a max (g): 0.085
EQ Mag (Mw): 7.7

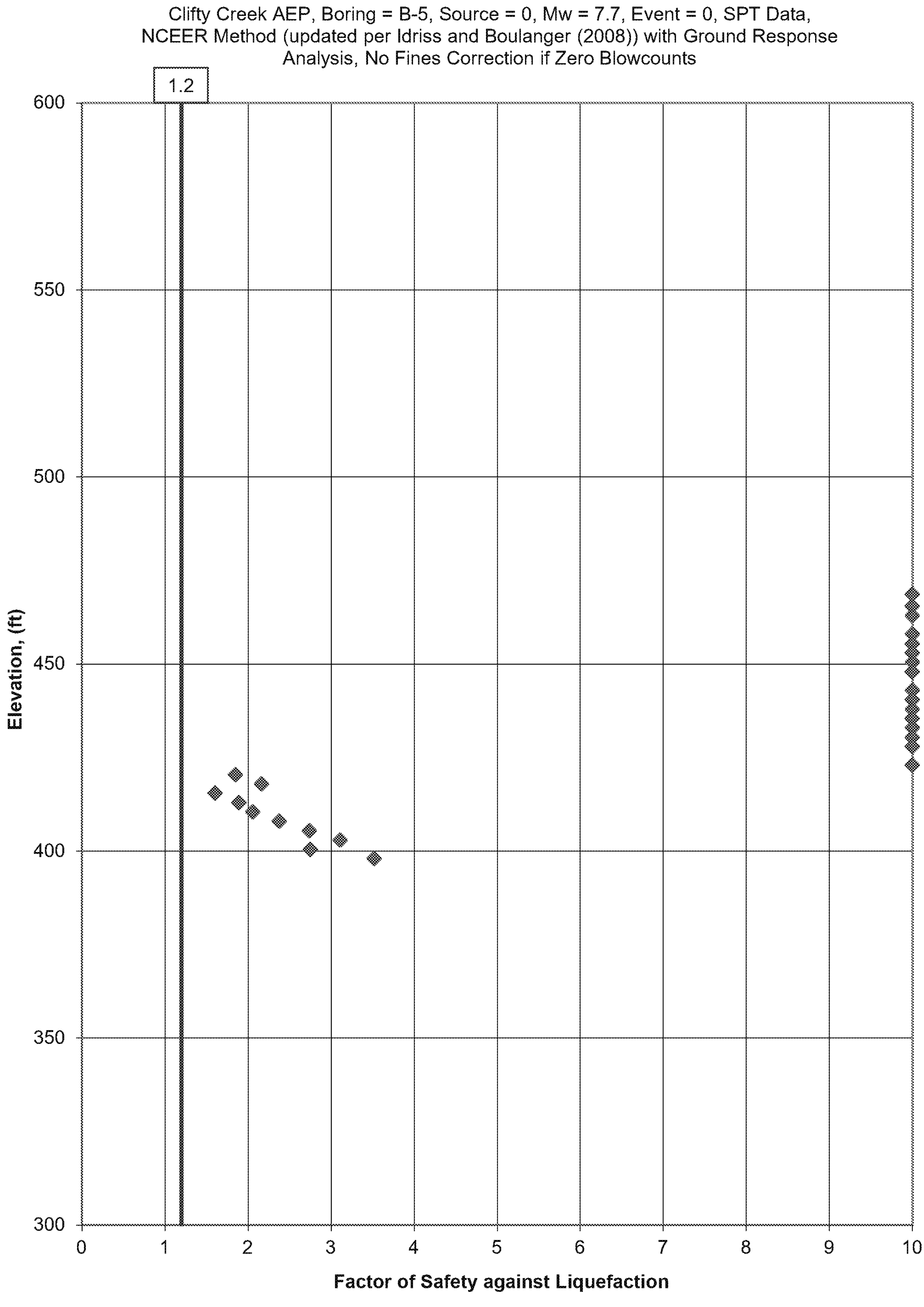
Event (MCE, OBE, etc.): 0
EQ Motion File: 0

Shake Stress Curve Fit Parameters
m4: 0
m3: 0
m2: 0
m1: 0

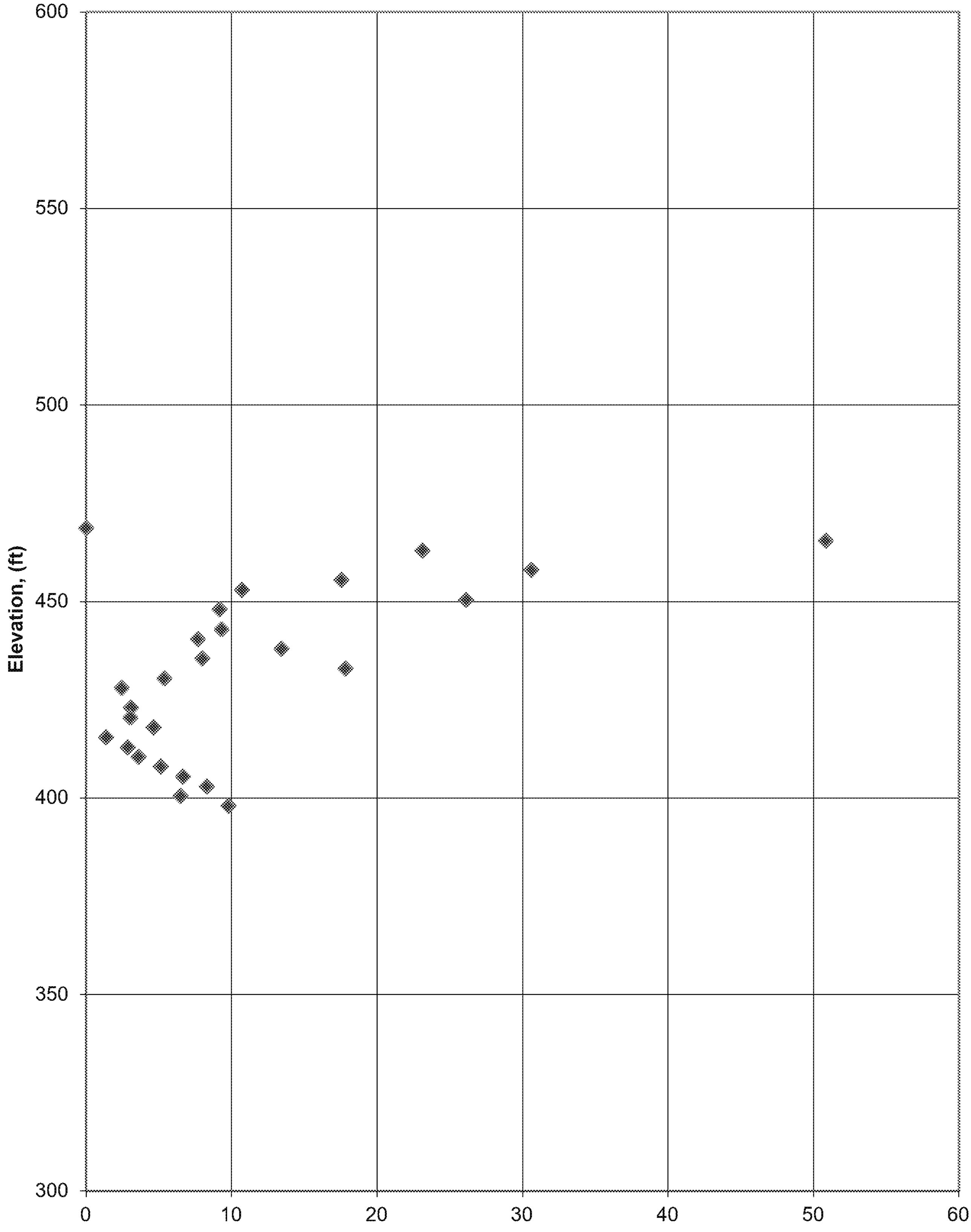
Boring ID: **B-5**
Top of Fill Elevation: 468.7
Fill Height: 0.0
Fill Total Unit Weight: 125
Fill Total Stress: 0.00

Note: A factor of safety shown as "NA" implies that the soil type is not appropriately evaluated using this methodology. This applies to soils classified as CL, CH, CL-ML and MH. These soils should be evaluated using methods for fine-grained soils. Also, "NA" implies that coarse grained soils with equivalent clean sand N-values greater than 30 are resistant to liquefaction.

Depth of Mid. Pt. of Sample (ft.) z	Vert. Total Stress during EQ (tsf) σ_v	Vert. Total Stress during EQ w/ Fill (tsf) $\sigma_{v\ with\ fill}$	Static Pore Pressure during EQ (tsf) u	Vert. Eff. Stress during EQ (tsf) σ'_v	Vert. Eff. Stress during EQ w/ Fill (tsf) $\sigma'_{v\ with\ fill}$	Alpha I	Beta I	Equivalent Clean Sand N-Value $(N_1)_{60cs}$	CRR7.5	Ksigma	Kalpha	Mag. Scaling Factor (Cm)	CRR Design EQ	Simplified Stress Reduction Coeff., r_d	Simplified CSR eq Design EQ	Max. Shake Stress (psf) Design EQ	Avg. Shake Stress (psf) Design EQ	Using SHAKE Data: CSR eq Design EQ	Using SHAKE Data: FS liq Design EQ	Using SHAKE Data: FS liq for plot	Simplified: FS liq Design EQ	Simplified: FS liq for plot
	totstr-top 0.16		u-top 0.00	effstr-top 0.16																		
3.3	0.20	0.20	0.00	0.20	0.20	NA	NA	NA	NA	NA	NA	0.95	NA	0.994	0.055	0	0	0.000	NA	10.0	NA	10.0
5.8	0.36	0.36	0.00	0.36	0.36	NA	NA	NA	NA	NA	NA	0.95	NA	0.989	0.055	0	0	0.000	NA	10.0	NA	10.0
10.8	0.67	0.67	0.00	0.67	0.67	NA	NA	NA	NA	NA	NA	0.95	NA	0.978	0.054	0	0	0.000	NA	10.0	NA	10.0
13.3	0.83	0.83	0.00	0.83	0.83	NA	NA	NA	NA	NA	NA	0.95	NA	0.972	0.054	0	0	0.000	NA	10.0	NA	10.0
15.8	0.98	0.98	0.00	0.98	0.98	NA	NA	NA	NA	NA	NA	0.95	NA	0.967	0.053	0	0	0.000	NA	10.0	NA	10.0
18.3	1.14	1.14	0.00	1.14	1.14	NA	NA	NA	NA	NA	NA	0.95	NA	0.961	0.053	0	0	0.000	NA	10.0	NA	10.0
20.8	1.30	1.30	0.00	1.30	1.30	NA	NA	NA	NA	NA	NA	0.95	NA	0.955	0.053	0	0	0.000	NA	10.0	NA	10.0
25.8	1.61	1.61	0.00	1.61	1.61	NA	NA	NA	NA	NA	NA	0.95	NA	0.939	0.052	0	0	0.000	NA	10.0	NA	10.0
28.3	1.77	1.77	0.00	1.77	1.77	NA	NA	NA	NA	NA	NA	0.95	NA	0.929	0.051	0	0	0.000	NA	10.0	NA	10.0
30.8	1.92	1.92	0.00	1.92	1.92	NA	NA	NA	NA	NA	NA	0.95	NA	0.917	0.051	0	0	0.000	NA	10.0	NA	10.0
33.3	2.08	2.08	0.00	2.08	2.08	NA	NA	NA	NA	NA	NA	0.95	NA	0.902	0.050	0	0	0.000	NA	10.0	NA	10.0
35.8	2.23	2.23	0.00	2.23	2.23	NA	NA	NA	NA	NA	NA	0.95	NA	0.885	0.049	0	0	0.000	NA	10.0	NA	10.0
38.3	2.39	2.39	0.07	2.32	2.32	NA	NA	NA	NA	NA	NA	0.95	NA	0.866	0.049	0	0	0.000	NA	10.0	NA	10.0
40.8	2.55	2.55	0.15	2.40	2.40	NA	NA	NA	NA	NA	NA	0.95	NA	0.844	0.050	0	0	0.000	NA	10.0	NA	10.0
45.8	2.86	2.86	0.30	2.56	2.56	NA	NA	NA	NA	NA	NA	0.95	NA	0.796	0.049	0	0	0.000	NA	10.0	NA	10.0
48.3	3.02	3.02	0.38	2.63	2.63	5.00	1.20	9	0.101	0.937	1.000	0.95	0.090	0.771	0.049	0	0	0.000	#DIV/0!	#DIV/0!	1.8	1.85
50.8	3.17	3.17	0.46	2.71	2.71	5.00	1.20	11	0.118	0.932	1.000	0.95	0.104	0.745	0.048	0	0	0.000	#DIV/0!	#DIV/0!	2.2	2.17
53.3	3.33	3.33	0.54	2.79	2.79	5.00	1.20	7	0.085	0.941	1.000	0.95	0.076	0.720	0.047	0	0	0.000	#DIV/0!	#DIV/0!	1.6	1.60
55.8	3.48	3.48	0.62	2.87	2.87	5.00	1.20	8	0.100	0.935	1.000	0.95	0.088	0.696	0.047	0	0	0.000	#DIV/0!	#DIV/0!	1.9	1.89
58.3	3.64	3.64	0.69	2.95	2.95	5.00	1.20	9	0.107	0.929	1.000003	0.95	0.094	0.674	0.046	0	0	0.000	#DIV/0!	#DIV/0!	2.1	2.05
60.8	3.80	3.80	0.77	3.02	3.02	5.00	1.20	11	0.123	0.920	1.000004	0.95	0.108	0.653	0.045	0	0	0.000	#DIV/0!	#DIV/0!	2.4	2.38
63.3	3.95	3.95	0.85	3.10	3.10	5.00	1.20	13	0.141	0.915	1.000006	0.95	0.122	0.634	0.045	0	0	0.000	#DIV/0!	#DIV/0!	2.7	2.74
65.8	4.11	4.11	0.93	3.18	3.18	5.00	1.20	15	0.159	0.906	1.000008	0.95	0.137	0.617	0.044	0	0	0.000	#DIV/0!	#DIV/0!	3.1	3.11
68.3	4.27	4.27	1.01	3.26	3.26	5.00	1.20	13	0.138	0.911	1.000006	0.95	0.120	0.602	0.044	0	0	0.000	#DIV/0!	#DIV/0!	2.8	2.75
70.8	4.42	4.42	1.08	3.34	3.34	5.00	1.20	17	0.178	0.898	1.00001	0.95	0.151	0.588	0.043	0	0	0.000	#DIV/0!	#DIV/0!	3.5	3.52


Clifty Creek AEP, Boring = B-5, Source = 0, Mw = 7.7, Event = 0, SPT Data, NCEER Method (updated per Idriss and Boulanger (2008)) with Ground Response Analysis, No Fines Correction if Zero Blowcounts
1.2
600
550
500
450
400
350
300
Elevation, (ft)
0
1
2
3
4
5
6
7
8
9
10
Factor of Safety against Liquefaction

Clifty Creek AEP, Boring = B-5, Source = 0, Mw = 7.7, Event = 0, SPT Data,
NCEER Method (updated per Idriss and Boulanger (2008)) with Ground Response
Analysis, No Fines Correction if Zero Blowcounts

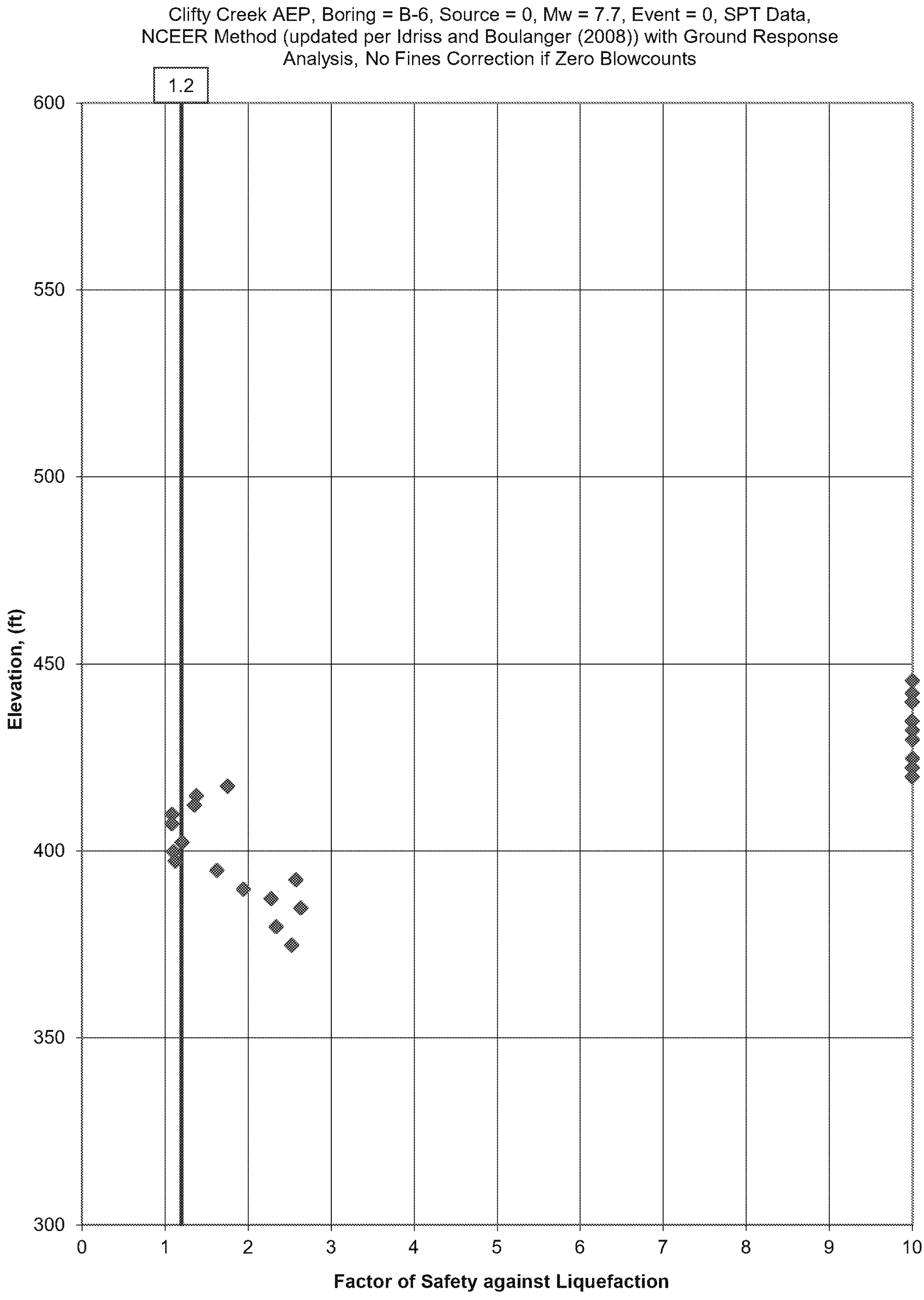


EQ Source	Event (MCE, OBE, etc.)	Shake Stress Curve Fit Parameters	
0	0	m4:	0
a max (g)		m3:	0
0.085	EQ Motion File	m2:	0
EQ Mag (Mw)	0	m1:	0
7.7			

Boring ID:	B-6
Top of Fill Elevation:	445.5
Fill Height:	0.0
Fill Total Unit Weight:	125
Fill Total Stress:	0.00

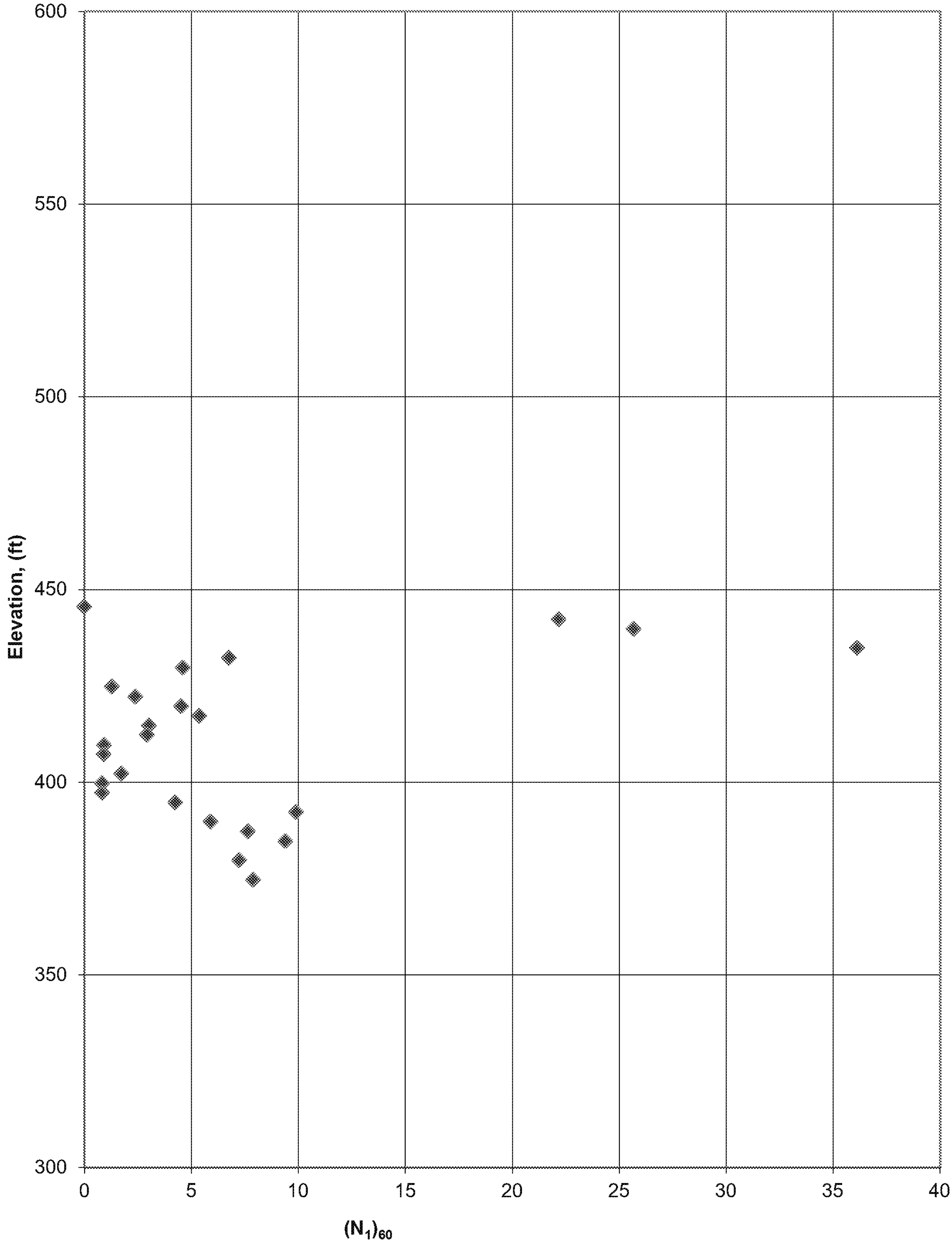
Note: A factor of safety shown as "NA" implies that the soil type is not appropriately evaluated using this methodology. This applies to soils classified as CL, CH, CL-ML and MH. These soils should be evaluated using methods for fine-grained soils. Also, "NA" implies that coarse grained soils with equivalent clean sand N-values greater than 30 are resistant to liquefaction.

Depth of Mid. Pt. of Sample (ft.) z	Vert. Total Stress during EQ (tsf) σ_v	Vert. Total Stress during EQ w/ Fill (tsf) $\sigma_{v\ with\ fill}$	Static Pore Pressure during EQ (tsf) u	Vert. Eff. Stress during EQ (tsf) σ'_v	Vert. Eff. Stress during EQ w/ Fill (tsf) $\sigma'_{v\ with\ fill}$	Alpha I	Beta I	Equivalent Clean Sand N-Value $(N_1)_{60cs}$	CRR7.5	Ksigma	Kalpha	Mag. Scaling Factor (Cm)	CRR Design EQ	Simplified Stress Reduction Coeff., r_d	Simplified CSR eq Design EQ	Max. Shake Stress (psf) Design EQ	Avg. Shake Stress (psf) Design EQ	Using SHAKE Data CSR eq Design EQ	Using SHAKE Data FS liq Design EQ	Using SHAKE Data FS liq for plot	Simplified FS liq Design EQ	Simplified FS liq for plot
	totstr-top 0.16		u-top 0.00	effstr-top 0.16																		
3.3	0.20	0.20	0.00	0.20	0.20	NA	NA	NA	NA	NA	NA	0.95	NA	0.994	0.055	0	0	0.000	NA	10.0	NA	10.0
5.8	0.36	0.36	0.00	0.36	0.36	NA	NA	NA	NA	NA	NA	0.95	NA	0.989	0.055	0	0	0.000	NA	10.0	NA	10.0
10.8	0.67	0.67	0.00	0.67	0.67	NA	NA	NA	NA	NA	NA	0.95	NA	0.978	0.054	0	0	0.000	NA	10.0	NA	10.0
13.3	0.83	0.83	0.00	0.83	0.83	NA	NA	NA	NA	NA	NA	0.95	NA	0.972	0.054	0	0	0.000	NA	10.0	NA	10.0
15.8	0.98	0.98	0.02	0.96	0.96	NA	NA	NA	NA	NA	NA	0.95	NA	0.967	0.055	0	0	0.000	NA	10.0	NA	10.0
20.8	1.30	1.30	0.18	1.12	1.12	NA	NA	NA	NA	NA	NA	0.95	NA	0.955	0.061	0	0	0.000	NA	10.0	NA	10.0
23.3	1.45	1.45	0.26	1.20	1.20	NA	NA	NA	NA	NA	NA	0.95	NA	0.948	0.064	0	0	0.000	NA	10.0	NA	10.0
25.8	1.61	1.61	0.34	1.27	1.27	NA	NA	NA	NA	NA	NA	0.95	NA	0.939	0.066	0	0	0.000	NA	10.0	NA	10.0
28.3	1.77	1.77	0.41	1.35	1.35	5.00	1.20	11	0.126	0.981	1.000	0.95	0.117	0.929	0.067	0	0	0.000	#DIV/0!	#DIV/0!	1.8	1.75
30.8	1.92	1.92	0.49	1.43	1.43	5.00	1.20	9	0.101	0.979	1.000	0.95	0.094	0.917	0.068	0	0	0.000	#DIV/0!	#DIV/0!	1.4	1.38
33.3	2.08	2.08	0.57	1.51	1.51	5.00	1.20	9	0.100	0.977	1.000	0.95	0.093	0.902	0.069	0	0	0.000	#DIV/0!	#DIV/0!	1.4	1.35
35.8	2.23	2.23	0.65	1.59	1.59	5.00	1.20	6	0.080	0.978	1.000	0.95	0.075	0.885	0.069	0	0	0.000	#DIV/0!	#DIV/0!	1.1	1.08
38.3	2.39	2.39	0.73	1.67	1.67	5.00	1.20	6	0.080	0.976	1.000	0.95	0.074	0.866	0.069	0	0	0.000	#DIV/0!	#DIV/0!	1.1	1.06
43.3	2.70	2.70	0.88	1.82	1.82	5.00	1.20	7	0.088	0.967	1.000	0.95	0.081	0.821	0.067	0	0	0.000	#DIV/0!	#DIV/0!	1.2	1.20
45.8	2.86	2.86	0.96	1.90	1.90	5.00	1.20	6	0.080	0.969	1.000	0.95	0.073	0.796	0.066	0	0	0.000	#DIV/0!	#DIV/0!	1.1	1.11
48.3	3.02	3.02	1.04	1.98	1.98	5.00	1.20	6	0.079	0.967	1.000	0.95	0.073	0.771	0.065	0	0	0.000	#DIV/0!	#DIV/0!	1.1	1.12
50.8	3.17	3.17	1.12	2.06	2.06	5.00	1.20	10	0.114	0.952	1.000	0.95	0.103	0.745	0.063	0	0	0.000	#DIV/0!	#DIV/0!	1.6	1.62
53.3	3.33	3.33	1.19	2.13	2.13	5.00	1.20	17	0.180	0.938	1.000	0.95	0.160	0.720	0.062	0	0	0.000	#DIV/0!	#DIV/0!	2.6	2.57
55.8	3.48	3.48	1.27	2.21	2.21	5.00	1.20	12	0.132	0.944	1.000	0.95	0.118	0.696	0.061	0	0	0.000	#DIV/0!	#DIV/0!	1.9	1.95
58.3	3.64	3.64	1.35	2.29	2.29	5.00	1.20	14	0.152	0.935	1.000008	0.95	0.135	0.674	0.059	0	0	0.000	#DIV/0!	#DIV/0!	2.3	2.27
60.8	3.80	3.80	1.43	2.37	2.37	5.00	1.20	16	0.173	0.928	1.000011	0.95	0.152	0.653	0.058	0	0	0.000	#DIV/0!	#DIV/0!	2.6	2.64
65.8	4.11	4.11	1.58	2.53	2.53	5.00	1.20	14	0.147	0.928	1.000007	0.95	0.130	0.617	0.055	0	0	0.000	#DIV/0!	#DIV/0!	2.3	2.34
70.8	4.42	4.42	1.74	2.68	2.68	5.00	1.20	14	0.155	0.922	1.000008	0.95	0.135	0.588	0.054	0	0	0.000	#DIV/0!	#DIV/0!	2.5	2.53



Clifty Creek AEP, Boring = B-6, Source = 0, Mw = 7.7, Event = 0, SPT Data,
NCEER Method (updated per Idriss and Boulanger (2008)) with Ground Response
Analysis, No Fines Correction if Zero Blowcounts
1.2
Elevation, (ft)
600
550
500
450
400
350
300
0
1
2
3
4
5
6
7
8
9
10
Factor of Safety against Liquefaction

Clifty Creek AEP, Boring = B-6, Source = 0, Mw = 7.7, Event = 0, SPT Data, NCEER Method (updated per Idriss and Boulanger (2008)) with Ground Response Analysis, No Fines Correction if Zero Blowcounts



LANDFILL RUNOFF COLLECTION POND: 2015 CCR MANDATE

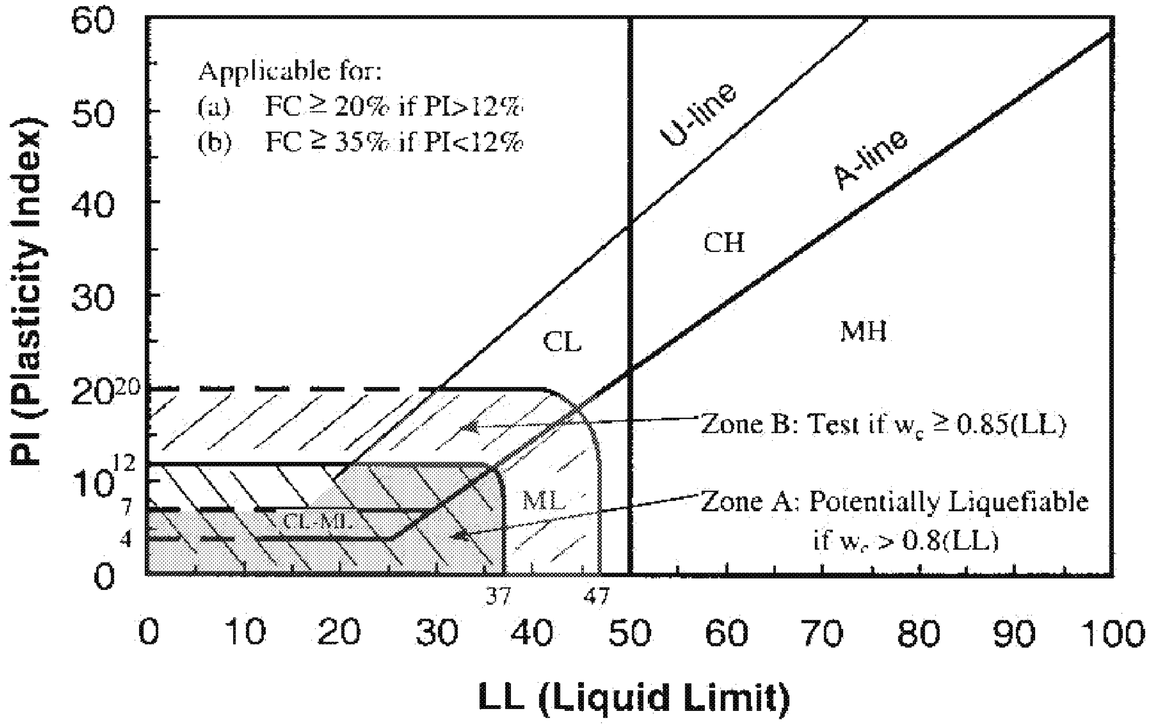
FINE-GRAINED ANALYSIS

Liquefaction Susceptibility of Fine-Grained Soils

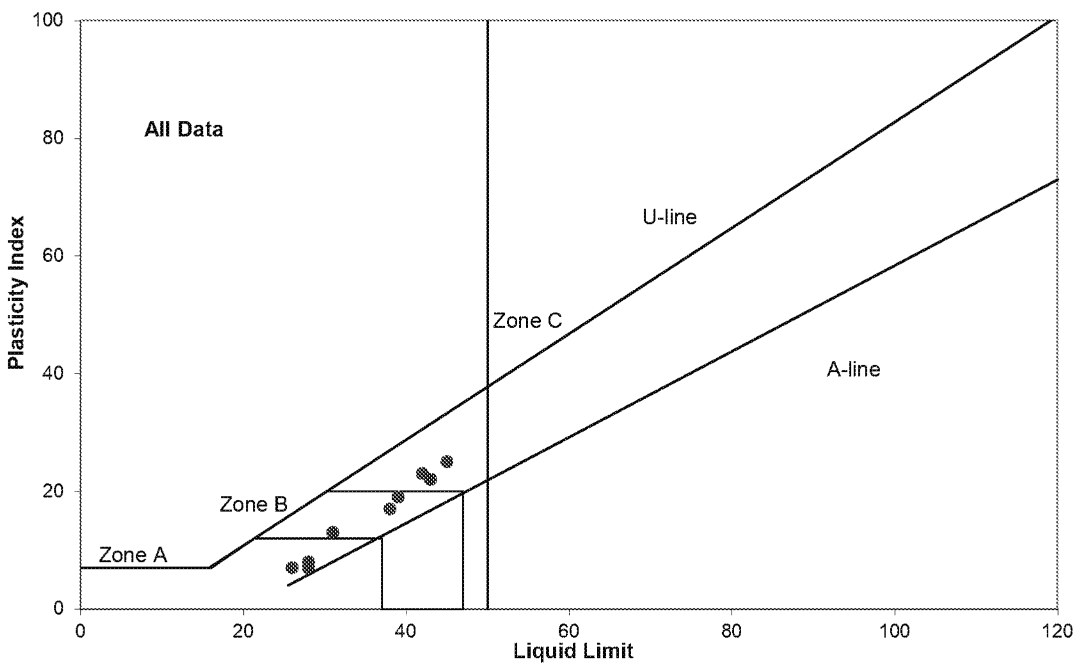
Stantec Project Number:	175553022
Project Name:	AEP Clifty Creek
Site/Structure Name:	Landfill Runoff Collection Pond Dam

Note: NP = Non-Plastic

									Sand-like versus Clay-like Behavior (-1 indicates result does not meet criteria, green shading indicates result does meet criteria, no results shown for non-plastic material)												Susceptibility of Clay-like Soils to Cyclic Softening (-1 indicates result does not meet criteria, green shading indicates result does meet criteria, no results shown for Sand-like materials)								
									Using Criteria published by Seed et al (2003)						Using Criteria published by Idriss and Boulanger (2008)		Using criteria published by MSHA (2010)			Overall Judgement based on 3 methods (sand-like or clay-like)	Using Criteria published by Seed et al (2003)		Using Criteria published by Bray and Sancio (2006)						Overall Judgement based on 2 methods (susceptibility)
									Meets criteria for sand-like behavior		Meets criteria for clay-like behavior				Meets criteria for sand-like behavior	Meets criteria for clay-like behavior	Meets criteria for sand-like behavior	Meets criteria for clay-like behavior	Borderline soils (treat as sand-like)		Meets all criteria for B (clay-like and potentially liquefiable, -2 indicates zone A but susceptible, -3 indicates not applicable due to fines content		Clay-like soil is susceptible (must meet both)		Clay-like soil is not susceptible (must meet one or both)		Clay-like soil is moderately susceptible		
Lab ID	Boring	Depth(s)	Soil Classification	NMC (w_c) (%)	% Passing #200	% Passing #40	LL	PI	LL in Zone A (see plot)	PI in Zone A (see plot)	LL in Zone B (see plot)	PI in Zone B (see plot)	LL in Zone C (see plot)	PI in Zone C (see plot)	PI < 7	PI >= 7	PI <= 7	P40>=35%, P200>=20%, and PI>=10	7 < PI < 10, or does not meet P40 or P200		LL	PI	w_c/LL >= 0.85	PI <= 12	w_c/LL < 0.80	PI > 18	Intermediate w_c/LL (see plot)	Intermediate PI (see plot)	
	B-7	27.2-27.8	CL	23.6	93.5	98	28	8	28	8	-1	-1	-1	-1	-1	8	-1	-1	8	Sand-like									
	B-8	25.5-25.8	CL	26.8	93.5	99.5	38	17	-1	-1	38	17	-1	-1	-1	17	-1	17	-1	Clay-like	-1	-1	-1.00	-1	0.71	17	-1.00	-1	Not Susceptible
	B-8	29.7-30.3	CL	23.5	79	99	45	25	-1	-1	-1	-1	45	25	-1	25	-1	25	-1	Clay-like	-1	-1	-1.00	-1	0.52	25	-1.00	-1	Not Susceptible
	B-9	20.2-20.8	CL	20.2	89	99.9	39	19	-1	-1	39	19	-1	-1	-1	19	-1	19	-1	Clay-like	-1	-1	-1.00	-1	0.52	19	-1.00	-1	Not Susceptible
	B-10	14.2-14.8	SM	20.0	100	29	NP	NP												Sand-like									
	B-10	16.2-16.8	CL-ML	20.6	100	84	28	7	28	7	-1	-1	-1	-1	-1	7	7	-1	-1	Sand-like									
3	B-12	10.0-11.5	CL	23.1	71.7	74.1	43	22	-1	-1	-1	-1	43	22	-1	22	-1	22	-1	Clay-like	-1	-1	-1.00	-1	0.54	22	-1.00	-1	Not Susceptible
7	B-12	30.0-31.5	CL	19.0	71.4	77.3	31	13	-1	-1	31	13	-1	-1	-1	13	-1	13	-1	Clay-like	-1	-1	-1.00	-1	0.61	13	-1.00	-1	Not Susceptible
10	B-12	45.0-46.5	CL-ML	18.7	82.2	99.2	26	7	26	7	-1	-1	-1	-1	-1	7	7	-1	-1	Sand-like									
11	B-12	50.0-51.5	ML	21.9	81.3	99.8	NP	NP												Sand-like									
13	B-12	60.0-61.5	SM	14.8	36.1	95.7	NP	NP												Sand-like									
15	B-12	70.0-71.5	ML	21.6	56.5	98.6	NP	NP												Sand-like									
17	B-12	80.0-81.5	ML	25.7	90.2	98.9	NP	NP												Sand-like									
20	B-12	95.0-96.5	CL	23.4	86.2	92.4	42	23	-1	-1	-1	-1	42	23	-1	23	-1	23	-1	Clay-like	-1	-1	-1.00	-1	0.56	23	-1.00	-1	Not Susceptible

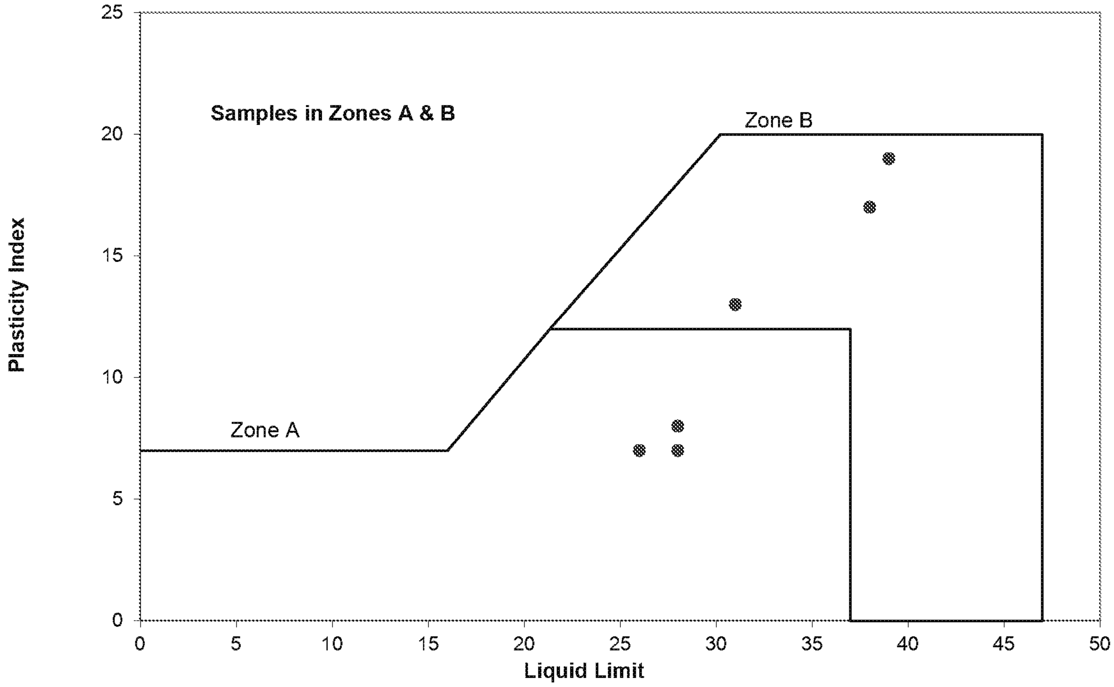


(a)

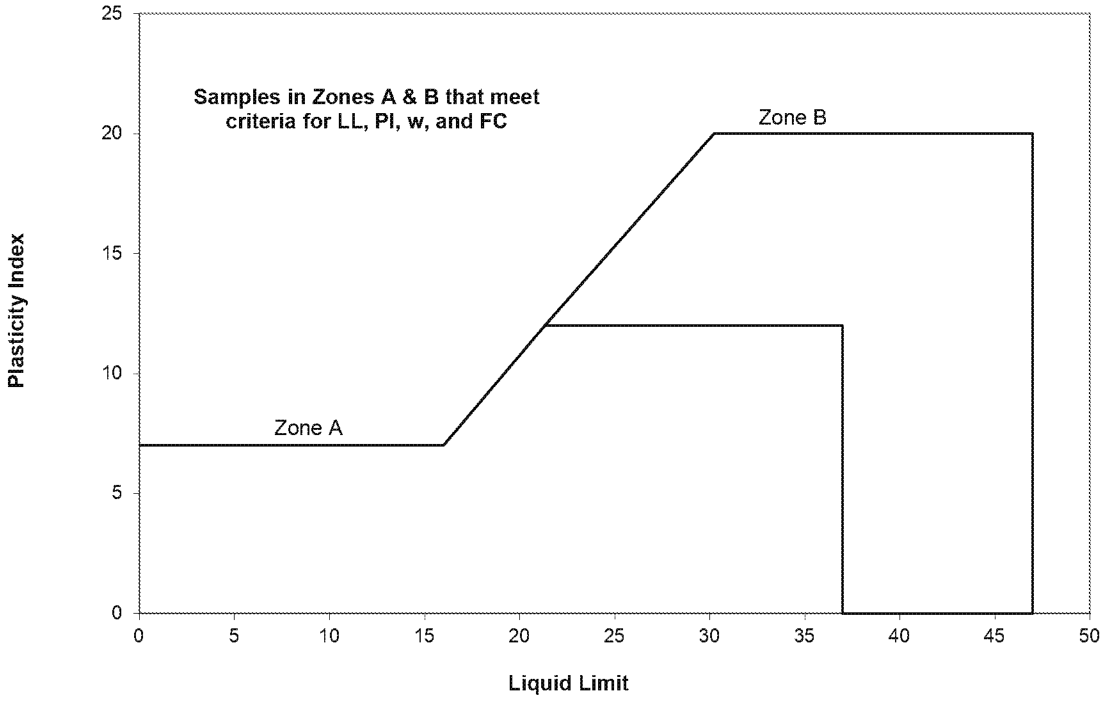


(b)

Screening Criteria for Liquefiable Fine-Grained Soils (Seed et al. 2003)

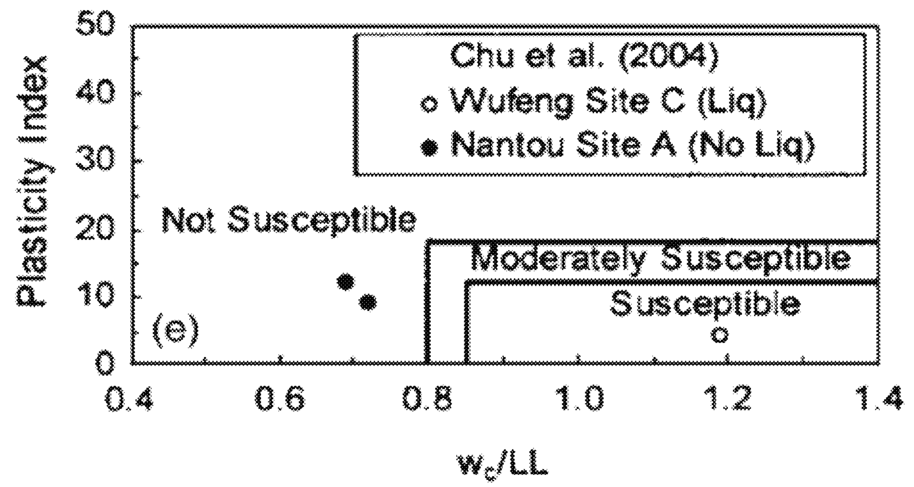


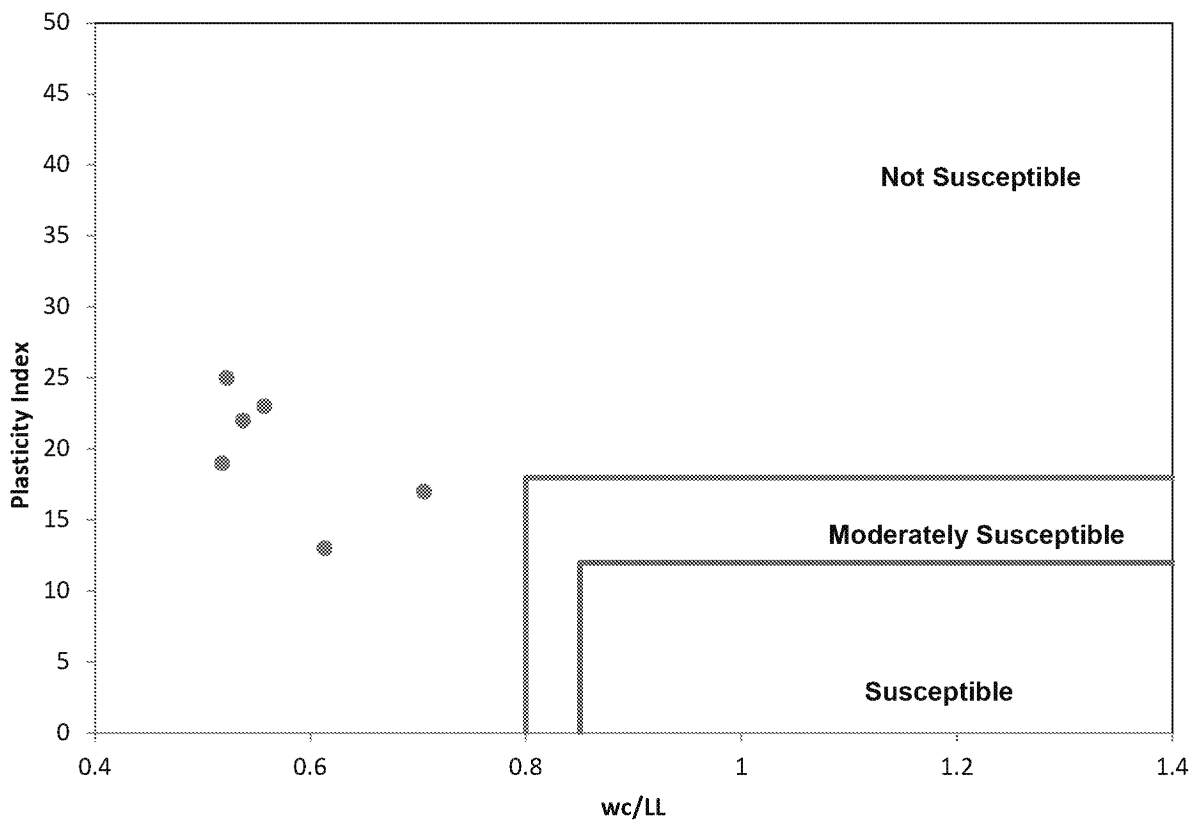
(c)



(d)

Screening Criteria for Liquefiable Fine-Grained Soils (Seed et al. 2003)





Screening Criteria for Assessing Liquefaction in Fine Grained Soils (Bray and Sancio 2006)

COARSE-GRAINED ANALYSIS

EQ Source: 0
a max (g): 0.085
EQ Mag (Mw): 7.7

Event (MCE, OBE, etc.): 0
EQ Motion File: 0

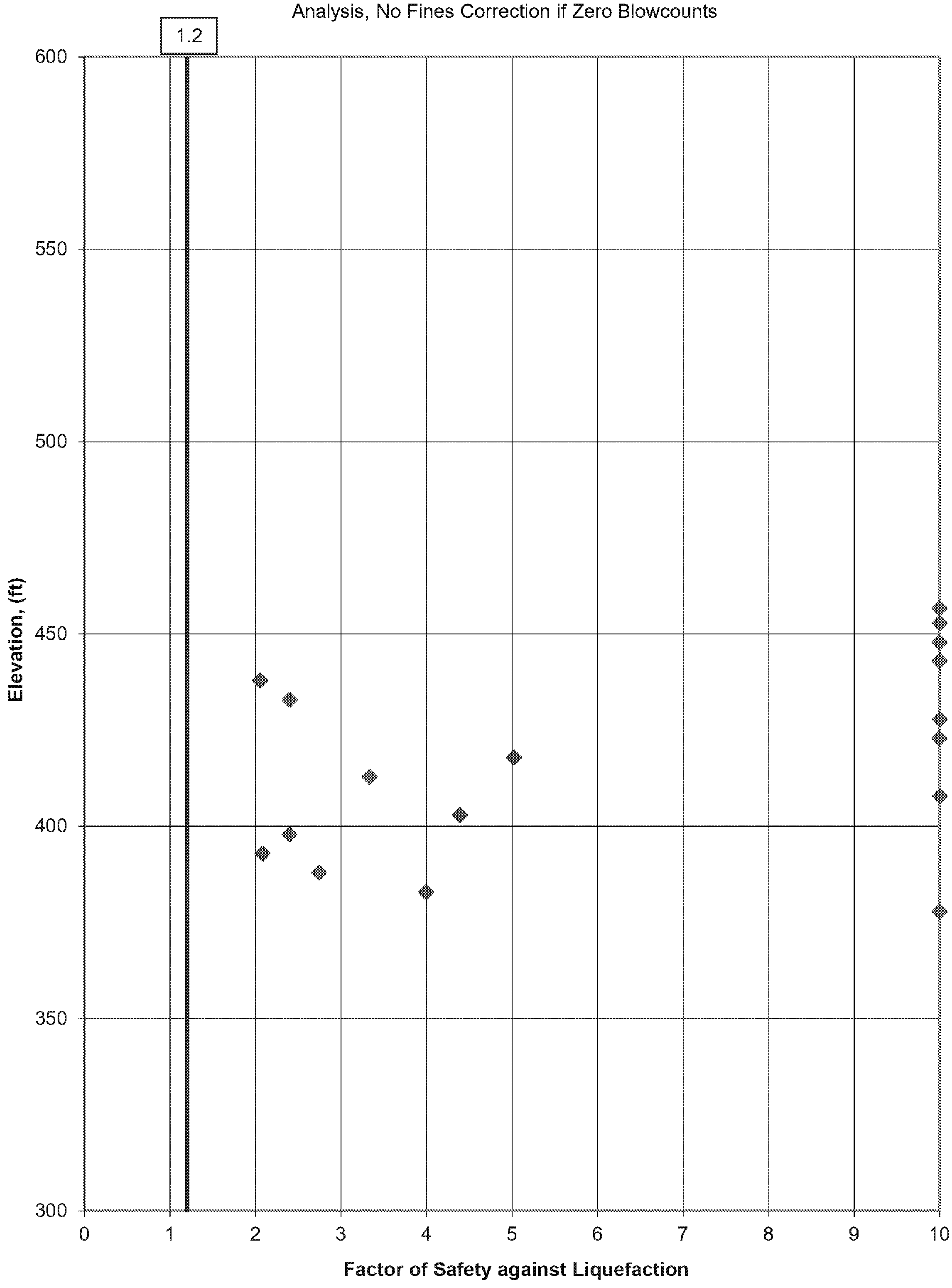
Shake Stress Curve Fit Parameters
m4: 0
m3: 0
m2: 0
m1: 0

Boring ID: **SI-1**
Top of Fill Elevation: 456.6
Fill Height: 0.0
Fill Total Unit Weight: 125
Fill Total Stress: 0.00

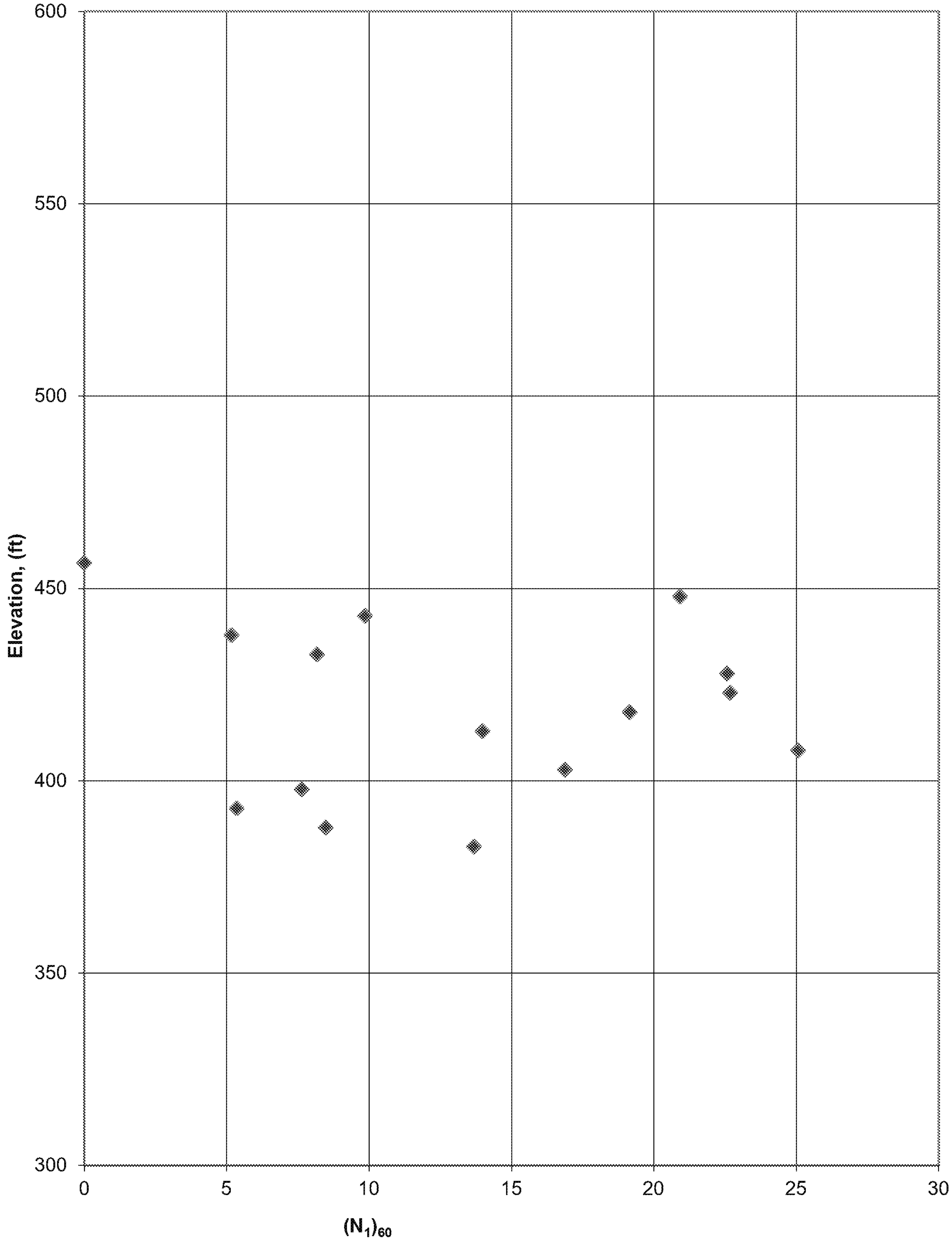
Note: A factor of safety shown as "NA" implies that the soil type is not appropriately evaluated using this methodology. This applies to soils classified as CL, CH, CL-ML and MH. These soils should be evaluated using methods for fine-grained soils. Also, "NA" implies that coarse grained soils with equivalent clean sand N-values greater than 30 are resistant to liquefaction.

Depth of Mid. Pt. of Sample (ft.) z	Vert. Total Stress during EQ (tsf) σ_v	Vert. Total Stress during EQ w/ Fill (tsf) $\sigma_{v\ with\ fill}$	Static Pore Pressure during EQ (tsf) u	Vert. Eff. Stress during EQ (tsf) σ'_v	Vert. Eff. Stress during EQ w/ Fill (tsf) $\sigma'_{v\ with\ fill}$	Alpha I	Beta I	Equivalent Clean Sand N-Value $(N_1)_{60cs}$	CRR7.5	Ksigma	Kalpha	Mag. Scaling Factor (Cm)	CRR Design EQ	Simplified Stress Reduction Coeff., r_d	Simplified CSR eq Design EQ	Max. Shake Stress (psf) Design EQ	Avg. Shake Stress (psf) Design EQ	Using SHAKE Data CSR eq Design EQ	Using SHAKE Data FS liq Design EQ	Using SHAKE Data FS liq for plot	Simplified FS liq Design EQ	Simplified FS liq for plot
	totstr-top 0.19		u-top 0.00	effstr-top 0.19																		
3.8	0.23	0.23	0.00	0.23	0.23	5.00	1.20	46	NA	1.000	1.000	0.95	NA	0.993	0.055	0	0	0.000	NA	10.0	NA	10.0
8.8	0.55	0.55	0.00	0.55	0.55	5.00	1.20	30	NA	1.000	1.000	0.95	NA	0.982	0.054	0	0	0.000	NA	10.0	NA	10.0
13.8	0.86	0.86	0.00	0.86	0.86	5.00	1.20	17	NA	1.000	1.000	0.95	NA	0.971	0.054	0	0	0.000	NA	10.0	NA	10.00
18.8	1.17	1.17	0.15	1.02	1.02	5.00	1.20	11	0.124	1.000	1.000	0.95	0.117	0.960	0.061	0	0	0.000	#DIV/0!	#DIV/0!	2.1	2.06
23.8	1.48	1.48	0.30	1.18	1.18	5.00	1.20	15	0.158	0.991	1.000	0.95	0.149	0.946	0.066	0	0	0.000	#DIV/0!	#DIV/0!	2.4	2.40
28.8	1.80	1.80	0.46	1.34	1.34	5.00	1.20	32	NA	0.966	1.000	0.95	NA	0.927	0.069	0	0	0.000	NA	10.0	NA	10.00
33.8	2.11	2.11	0.62	1.49	1.49	5.00	1.20	32	NA	0.950	1.000	0.95	NA	0.899	0.070	0	0	0.000	NA	10.0	NA	10.00
38.8	2.42	2.42	0.77	1.65	1.65	5.00	1.20	28	0.369	0.943	1.000	0.95	0.330	0.862	0.070	0	0	0.000	#DIV/0!	#DIV/0!	5.0	5.02
43.8	2.73	2.73	0.93	1.81	1.81	5.00	1.20	22	0.239	0.945	1.000	0.95	0.214	0.816	0.068	0	0	0.000	#DIV/0!	#DIV/0!	3.3	3.34
48.8	3.05	3.05	1.08	1.96	1.96	5.00	1.20	35	NA	0.899	1.000	0.95	NA	0.765	0.066	0	0	0.000	NA	10.0	NA	10.00
53.8	3.36	3.36	1.24	2.12	2.12	5.00	1.20	25	0.297	0.920	1.000	0.95	0.259	0.715	0.063	0	0	0.000	#DIV/0!	#DIV/0!	4.4	4.39
58.8	3.67	3.67	1.40	2.28	2.28	5.00	1.20	14	0.152	0.936	1.000	0.95	0.135	0.670	0.060	0	0	0.000	#DIV/0!	#DIV/0!	2.4	2.40
63.8	3.98	3.98	1.55	2.43	2.43	5.00	1.20	11	0.126	0.937	1.000	0.95	0.112	0.631	0.057	0	0	0.000	#DIV/0!	#DIV/0!	2.1	2.08
68.8	4.30	4.30	1.71	2.59	2.59	5.00	1.20	15	0.162	0.923	1.000	0.95	0.142	0.599	0.055	0	0	0.000	#DIV/0!	#DIV/0!	2.7	2.74
73.8	4.61	4.61	1.86	2.75	2.75	5.00	1.20	21	0.234	0.902	1.000	0.95	0.200	0.573	0.053	0	0	0.000	#DIV/0!	#DIV/0!	4.0	3.99
78.8	4.92	4.92	2.02	2.90	2.90	5.00	1.20	62	NA	0.697	1.000	0.95	NA	0.553	0.052	0	0	0.000	NA	10.0	NA	10.00

Clifty Creek AEP, Boring = SI-1, Source = 0, Mw = 7.7, Event = 0, SPT Data, NCEER Method (updated per Idriss and Boulanger (2008)) with Ground Response Analysis, No Fines Correction if Zero Blowcounts



Clifty Creek AEP, Boring = SI-1, Source = 0, Mw = 7.7, Event = 0, SPT Data,
NCEER Method (updated per Idriss and Boulanger (2008)) with Ground Response
Analysis, No Fines Correction if Zero Blowcounts



EQ Source	0
a max (g)	0.085
EQ Mag (Mw)	7.7

Event (MCE, OBE, etc.): 0

EQ Motion File: 0

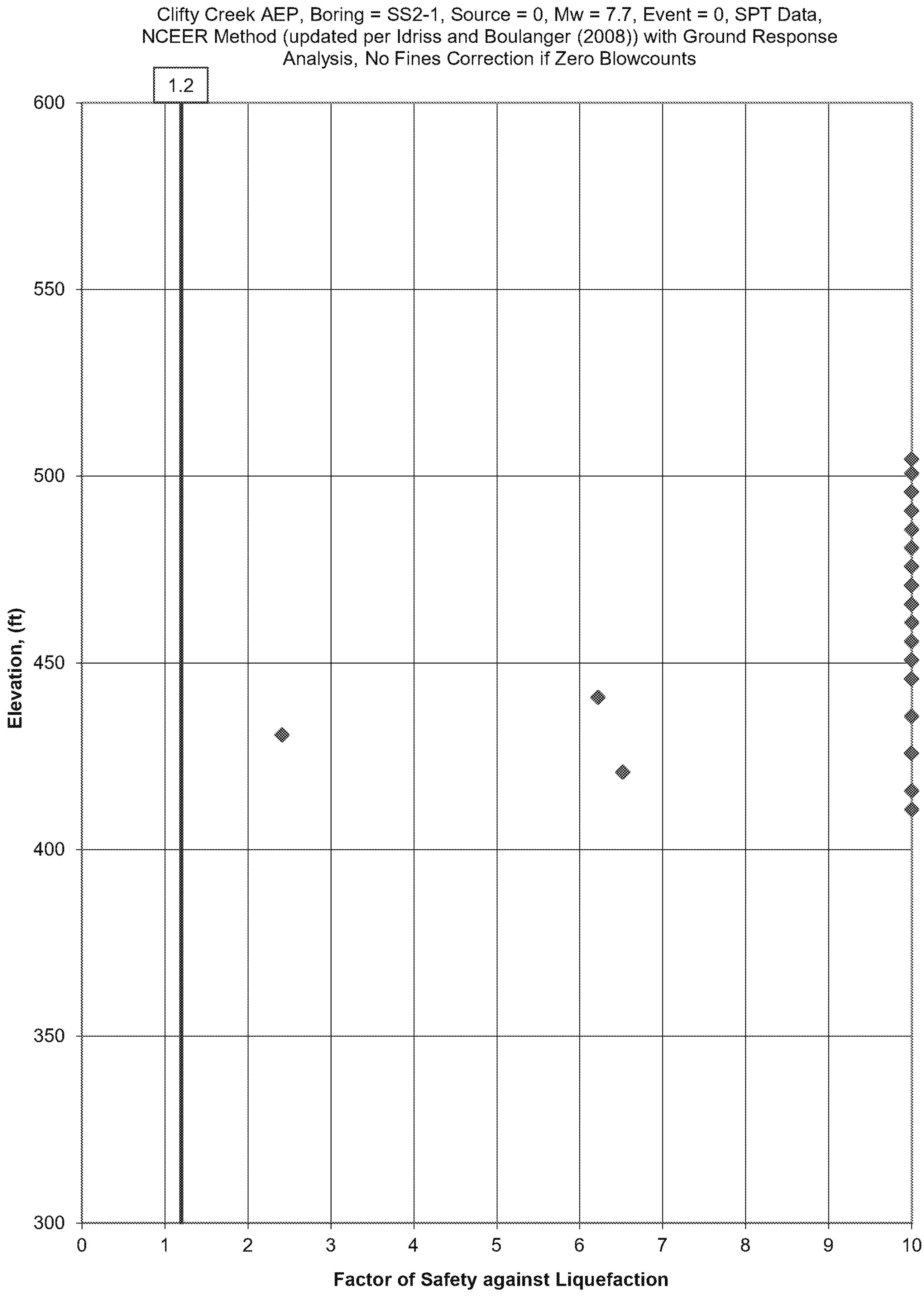
Shake Stress Curve Fit Parameters

m4:	0
m3:	0
m2:	0
m1:	0

Boring ID:	**SS2-1**	
Top of Fill Elevation:	504.5	ft *(if no fill, then set this equal to top of SPT hole elev.)*
Fill Height:	0.0	ft *(relative to ground surface during SPT)*
Fill Total Unit Weight:	125	pcf
Fill Total Stress:	0.00	tsf

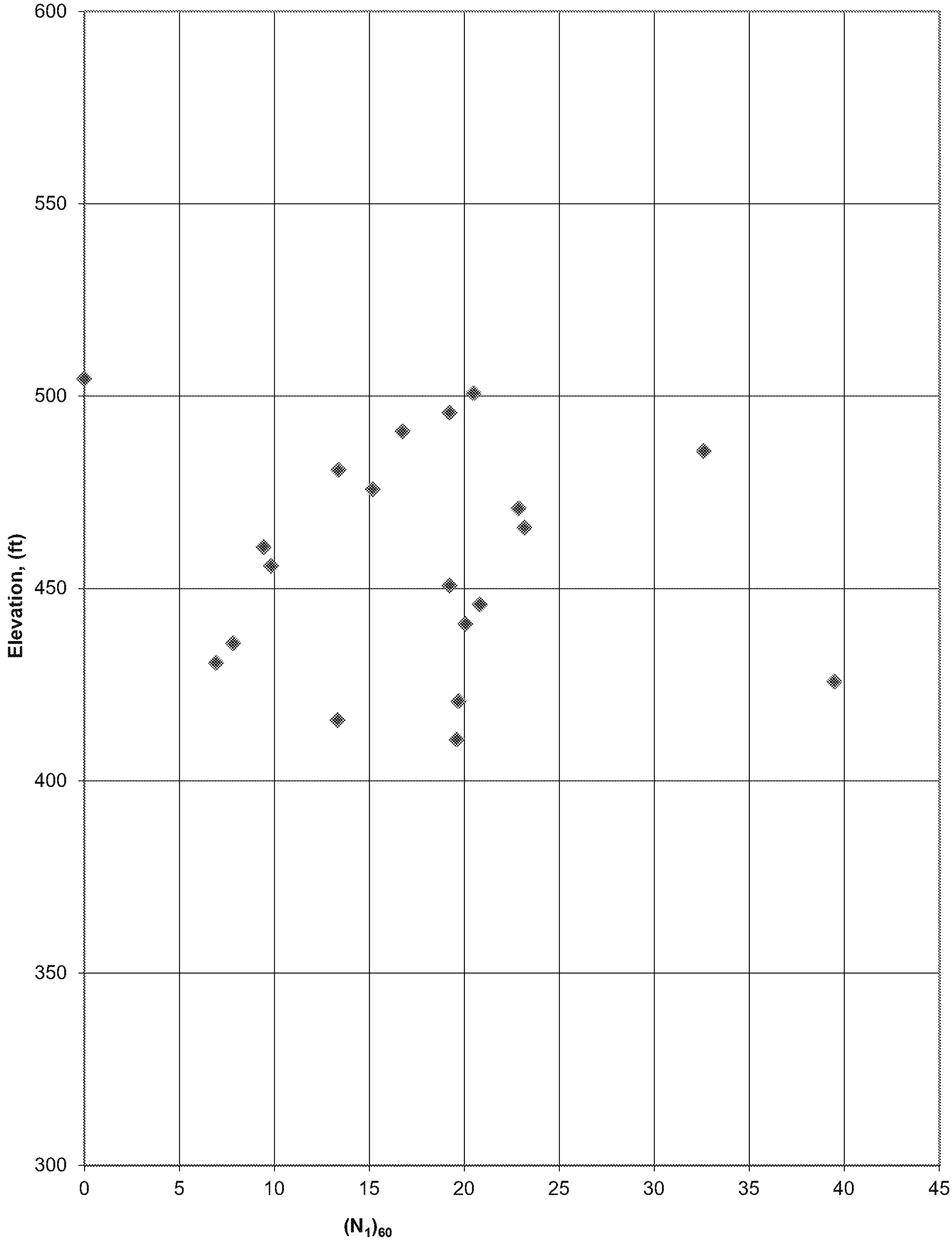
Note: A factor of safety shown as "NA" implies that the soil type is not appropriately evaluated using this methodology. This applies to soils classified as CL, CH, CL-ML and MH. These soils should be evaluated using methods for fine-grained soils. Also, "NA" implies that coarse grained soils with equivalent clean sand N-values greater than 30 are resistant to liquefaction.

Depth of Mid. Pt. of Sample (ft.) z	Vert. Total Stress during EQ (tsf) σ_v	Vert. Total Stress during EQ w/ Fill (tsf) $\sigma_{v\,with\,fill}$	Static Pore Pressure during EQ (tsf) u	Vert. Eff. Stress during EQ (tsf) σ'_v	Vert. Eff. Stress during EQ w/ Fill (tsf) $\sigma'_{v\,with\,fill}$	Effective All-Around Stress during EQ (psf) σ'_m	Shear Modulus during EQ (ksf) G_{max}	Alpha I	Beta I	Equivalent Clean Sand N-Value $(N_1)_{60cs}$	CRR7.5	Ksigma	Kalpha	Mag. Scaling Factor (Cm)	CRR Design EQ	Simplified Stress Reduction Coeff., r_d	Simplified CSR eq Design EQ	Max. Shake Stress (psf) Design EQ	Avg. Shake Stress (psf) Design EQ	Using SHAKE Data CSR eq Design EQ	Using SHAKE Data FS liq Design EQ	Using SHAKE Data FS liq for plot	Simplified FS liq Design EQ	Simplified FS liq for plot
	totstr-top 0.19		u-top 0.00	effstr-top 0.19																				
3.8	0.23	0.23	0.00	0.23	0.23	312.50	#NUM!	NA	NA	NA	NA	NA	NA	0.95	NA	0.993	0.055	0	0	0.000	NA	10.0	NA	10.00
8.8	0.55	0.55	0.00	0.55	0.55	729.17	#NUM!	NA	NA	NA	NA	NA	NA	0.95	NA	0.982	0.054	0	0	0.000	NA	10.0	NA	10.00
13.8	0.86	0.86	0.12	0.74	0.74	989.83	#NUM!	NA	NA	NA	NA	NA	NA	0.95	NA	0.971	0.062	0	0	0.000	NA	10.0	NA	10.00
18.8	1.17	1.17	0.27	0.90	0.90	1198.50	#NUM!	NA	NA	NA	NA	NA	NA	0.95	NA	0.960	0.069	0	0	0.000	NA	10.0	NA	10.00
23.8	1.48	1.48	0.43	1.06	1.06	1407.17	#NUM!	NA	NA	NA	NA	NA	NA	0.95	NA	0.946	0.074	0	0	0.000	NA	10.0	NA	10.00
28.8	1.80	1.80	0.59	1.21	1.21	1615.83	#NUM!	NA	NA	NA	NA	NA	NA	0.95	NA	0.927	0.076	0	0	0.000	NA	10.0	NA	10.00
33.8	2.11	2.11	0.74	1.37	1.37	1824.50	#NUM!	NA	NA	NA	NA	NA	NA	0.95	NA	0.899	0.077	0	0	0.000	NA	10.0	NA	10.00
38.8	2.42	2.42	0.90	1.52	1.52	2033.17	#NUM!	NA	NA	NA	NA	NA	NA	0.95	NA	0.862	0.076	0	0	0.000	NA	10.0	NA	10.00
43.8	2.73	2.73	1.05	1.68	1.68	2241.83	#NUM!	NA	NA	NA	NA	NA	NA	0.95	NA	0.816	0.073	0	0	0.000	NA	10.0	NA	10.00
48.8	3.05	3.05	1.21	1.84	1.84	2450.50	#NUM!	NA	NA	NA	NA	NA	NA	0.95	NA	0.765	0.070	0	0	0.000	NA	10.0	NA	10.00
53.8	3.36	3.36	1.37	1.99	1.99	2659.17	#NUM!	NA	NA	NA	NA	NA	NA	0.95	NA	0.715	0.067	0	0	0.000	NA	10.0	NA	10.00
58.8	3.67	3.67	1.52	2.15	2.15	2867.83	#NUM!	NA	NA	NA	NA	NA	NA	0.95	NA	0.670	0.063	0	0	0.000	NA	10.0	NA	10.00
63.8	3.98	3.98	1.68	2.31	2.31	3076.50	#NUM!	5.00	1.20	29	0.414	0.896	1.000	0.95	0.352	0.631	0.060	0	0	0.000	#DIV/0!	#DIV/0!	6.2	6.22
68.8	4.30	4.30	1.83	2.46	2.46	3285.17	#NUM!	NA	NA	NA	NA	NA	NA	0.95	NA	0.599	0.058	0	0	0.000	NA	10.0	NA	10.00
73.8	4.61	4.61	1.99	2.62	2.62	3493.83	#NUM!	5.00	1.20	13	0.144	0.928	1.000	0.95	0.126	0.573	0.056	0	0	0.000	#DIV/0!	#DIV/0!	2.4	2.41
78.8	4.92	4.92	2.15	2.78	2.78	3702.50	#NUM!	5.00	1.20	52	NA	0.711	1.000	0.95	NA	0.553	0.054	0	0	0.000	NA	10.0	NA	10.00
83.8	5.23	5.23	2.30	2.93	2.93	3911.17	#NUM!	5.00	1.20	29	0.393	0.869	1.000	0.95	0.324	0.536	0.053	0	0	0.000	#DIV/0!	#DIV/0!	6.5	6.52
88.8	5.55	5.55	2.46	3.09	3.09	4119.83	#NUM!	NA	NA	NA	NA	NA	NA	0.95	NA	0.522	0.052	0	0	0.000	NA	10.0	NA	10.00
93.8	5.86	5.86	2.61	3.25	3.25	4328.50	#NUM!	NA	NA	NA	NA	NA	NA	0.95	NA	0.511	0.051	0	0	0.000	NA	10.0	NA	10.00



Clifty Creek AEP, Boring = SS2-1, Source = 0, Mw = 7.7, Event = 0, SPT Data, NCEER Method (updated per Idriss and Boulanger (2008)) with Ground Response Analysis, No Fines Correction if Zero Blowcounts
1.2
Elevation, (ft)
600
550
500
450
400
350
300
0
1
2
3
4
5
6
7
8
9
10
Factor of Safety against Liquefaction

Clifty Creek AEP, Boring = SS2-1, Source = 0, Mw = 7.7, Event = 0, SPT Data, NCEER Method (updated per Idriss and Boulanger (2008)) with Ground Response Analysis, No Fines Correction if Zero Blowcounts



EQ Source	a max (g)	EQ Mag (Mw)
0	0.085	7.7

Event (MCE, OBE, etc.): 0

EQ Motion File: 0

Shake Stress Curve Fit Parameters

m4:	0
m3:	0
m2:	0
m1:	0

Boring ID:	**SS2-4**
Top of Fill Elevation:	439.8
Fill Height:	0.0
Fill Total Unit Weight:	125
Fill Total Stress:	0.00

Note: A factor of safety shown as "NA" implies that the soil type is not appropriately evaluated using this methodology. This applies to soils classified as CL, CH, CL-ML and MH. These soils should be evaluated using methods for fine-grained soils. Also, "NA" implies that coarse grained soils with equivalent clean sand N-values greater than 30 are resistant to liquefaction.

Depth of Mid. Pt. of Sample (ft.) z	Vert. Total Stress during EQ (tsf) σ_v	Vert. Total Stress during EQ w/ Fill (tsf) $\sigma_{v\ with\ fill}$	Static Pore Pressure during EQ (tsf) u	Vert. Eff. Stress during EQ (tsf) σ'_v	Vert. Eff. Stress during EQ w/ Fill (tsf) $\sigma'_{v\ with\ fill}$	Alpha I	Beta I	Equivalent Clean Sand N-Value $(N_1)_{60cs}$	CRR7.5	Ksigma	Kalpha	Mag. Scaling Factor (Cm)	CRR Design EQ	Simplified Stress Reduction Coeff., r_d	Simplified CSR eq Design EQ	Max. Shake Stress (psf) Design EQ	Avg. Shake Stress (psf) Design EQ	Using SHAKE Data CSR eq Design EQ	Using SHAKE Data FS liq Design EQ	Using SHAKE Data FS liq for plot	Simplified FS liq Design EQ	Simplified FS liq for plot
	totstr-top 0.16		u-top 0.00	effstr-top 0.16																		
3.3	0.20	0.20	0.00	0.20	0.20	NA	NA	NA	NA	NA	NA	0.95	NA	0.994	0.055	0	0	0.000	NA	10.0	NA	10.00
8.3	0.52	0.52	0.00	0.52	0.52	NA	NA	NA	NA	NA	NA	0.95	NA	0.983	0.054	0	0	0.000	NA	10.0	NA	10.00
13.3	0.83	0.83	0.10	0.73	0.73	NA	NA	NA	NA	NA	NA	0.95	NA	0.972	0.061	0	0	0.000	NA	10.0	NA	10.00
18.3	1.14	1.14	0.26	0.88	0.88	5.00	1.20	21	0.224	1.000	1.000	0.95	0.212	0.961	0.069	0	0	0.000	#DIV/0!	#DIV/0!	3.3	3.29
23.3	1.45	1.45	0.41	1.04	1.04	NA	NA	NA	NA	NA	NA	0.95	NA	0.948	0.073	0	0	0.000	NA	10.0	NA	10.00
28.3	1.77	1.77	0.57	1.20	1.20	NA	NA	NA	NA	NA	NA	0.95	NA	0.929	0.076	0	0	0.000	NA	10.0	NA	10.00
33.3	2.08	2.08	0.73	1.35	1.35	NA	NA	NA	NA	NA	NA	0.95	NA	0.902	0.077	0	0	0.000	NA	10.0	NA	10.00
38.3	2.39	2.39	0.88	1.51	1.51	NA	NA	NA	NA	NA	NA	0.95	NA	0.866	0.076	0	0	0.000	NA	10.0	NA	10.00
43.3	2.70	2.70	1.04	1.67	1.67	NA	NA	NA	NA	NA	NA	0.95	NA	0.821	0.074	0	0	0.000	NA	10.0	NA	10.00
48.3	3.02	3.02	1.19	1.82	1.82	NA	NA	NA	NA	NA	NA	0.95	NA	0.771	0.070	0	0	0.000	NA	10.0	NA	10.00
53.3	3.33	3.33	1.35	1.98	1.98	NA	NA	NA	NA	NA	NA	0.95	NA	0.720	0.067	0	0	0.000	NA	10.0	NA	10.00
58.3	3.64	3.64	1.51	2.14	2.14	NA	NA	NA	NA	NA	NA	0.95	NA	0.674	0.063	0	0	0.000	NA	10.0	NA	10.00
63.3	3.95	3.95	1.66	2.29	2.29	5.00	1.20	21	0.228	0.920	1.000	0.95	0.199	0.634	0.060	0	0	0.000	#DIV/0!	#DIV/0!	3.5	3.50

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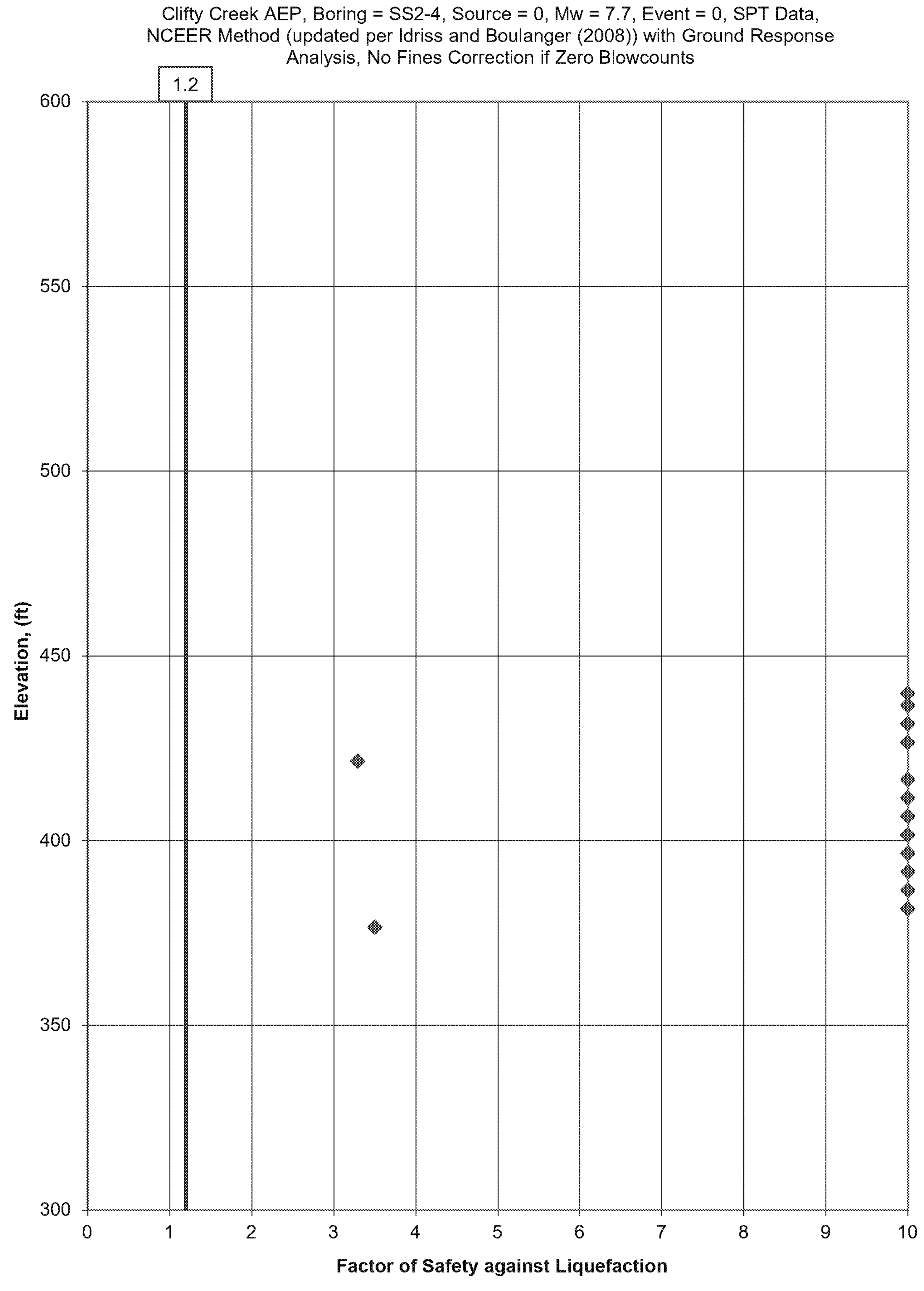
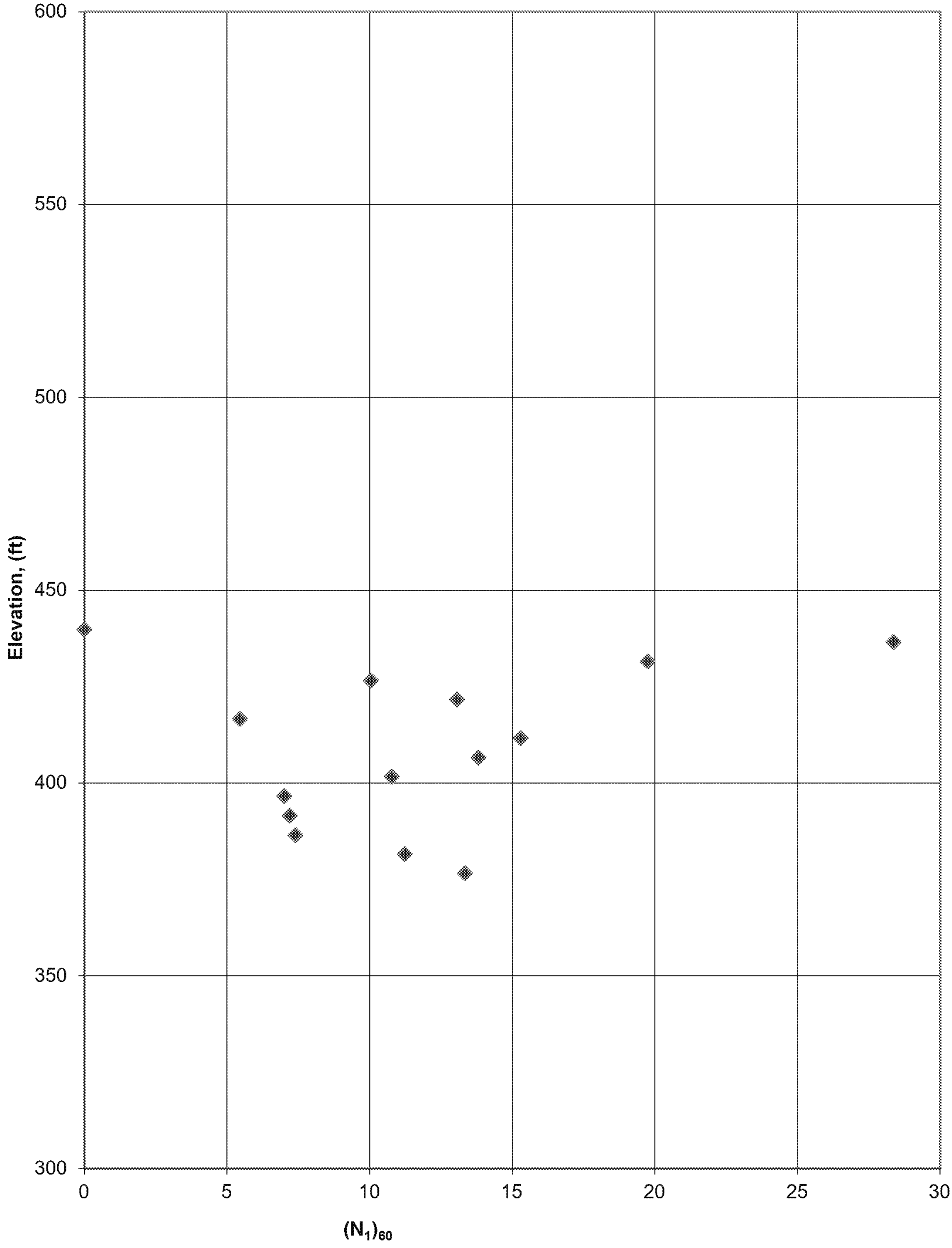


Clifty Creek AEP, Boring = SS2-4, Source = 0, Mw = 7.7, Event = 0, SPT Data,
NCEER Method (updated per Idriss and Boulanger (2008)) with Ground Response
Analysis, No Fines Correction if Zero Blowcounts
1.2
Elevation, (ft)
600
550
500
450
400
350
300
0
1
2
3
4
5
6
7
8
9
10
Factor of Safety against Liquefaction

Clifty Creek AEP, Boring = SS2-4, Source = 0, Mw = 7.7, Event = 0, SPT Data, NCEER Method (updated per Idriss and Boulanger (2008)) with Ground Response Analysis, No Fines Correction if Zero Blowcounts



EQ Source	Event (MCE, OBE, etc.)	EQ Motion File	a max (g)	EQ Mag (Mw)
0	0	0	0.085	7.7

Shake Stress Curve Fit Parameters

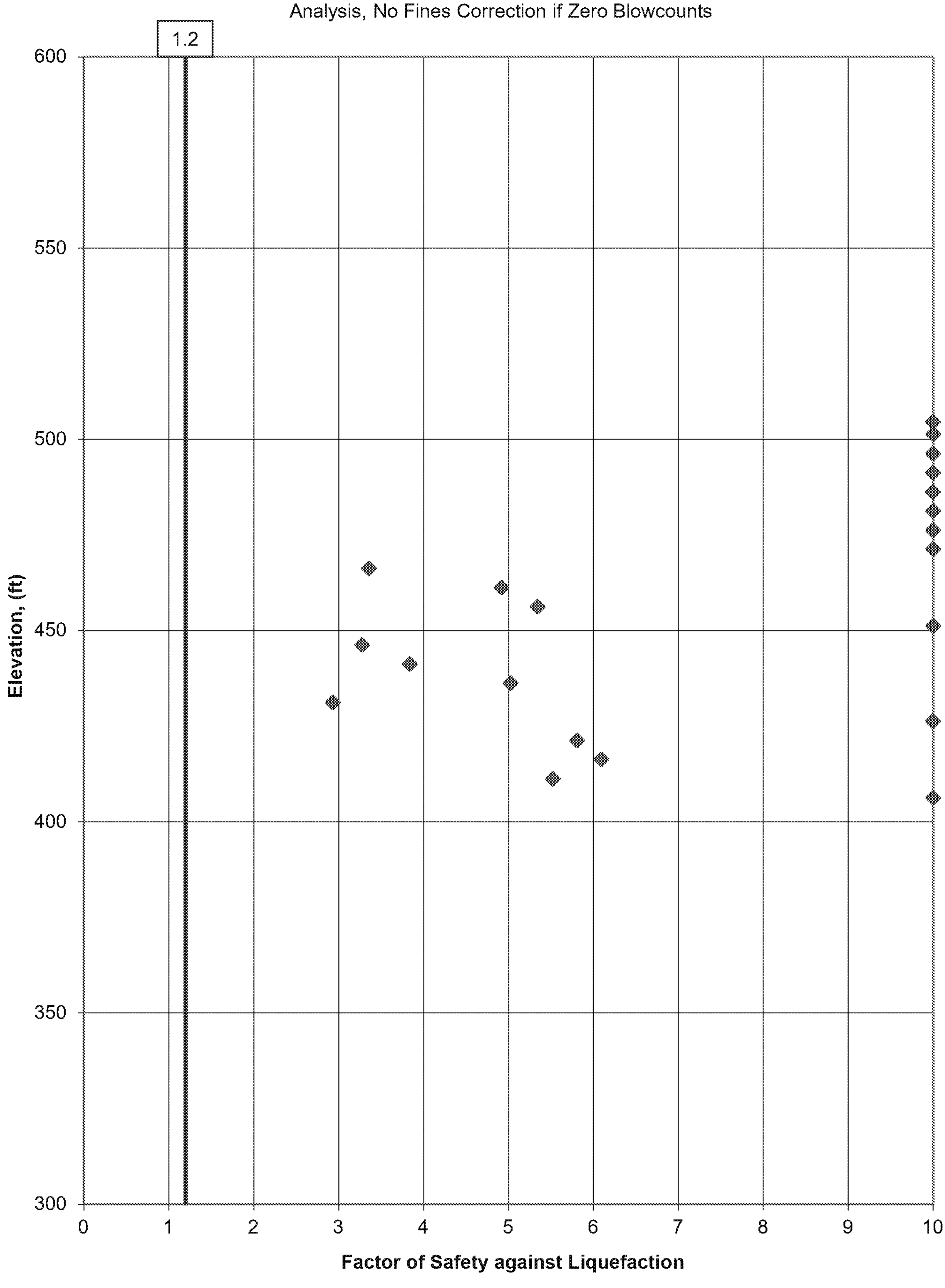
Parameter	Value
m4:	0
m3:	0
m2:	0
m1:	0

Boring ID:	SS3-1	
Top of Fill Elevation:	504.5	ft *(if no fill, then set this equal to top of SPT hole elev.)*
Fill Height:	0.0	ft *(relative to ground surface during SPT)*
Fill Total Unit Weight:	125	pcf
Fill Total Stress:	0.00	tsf

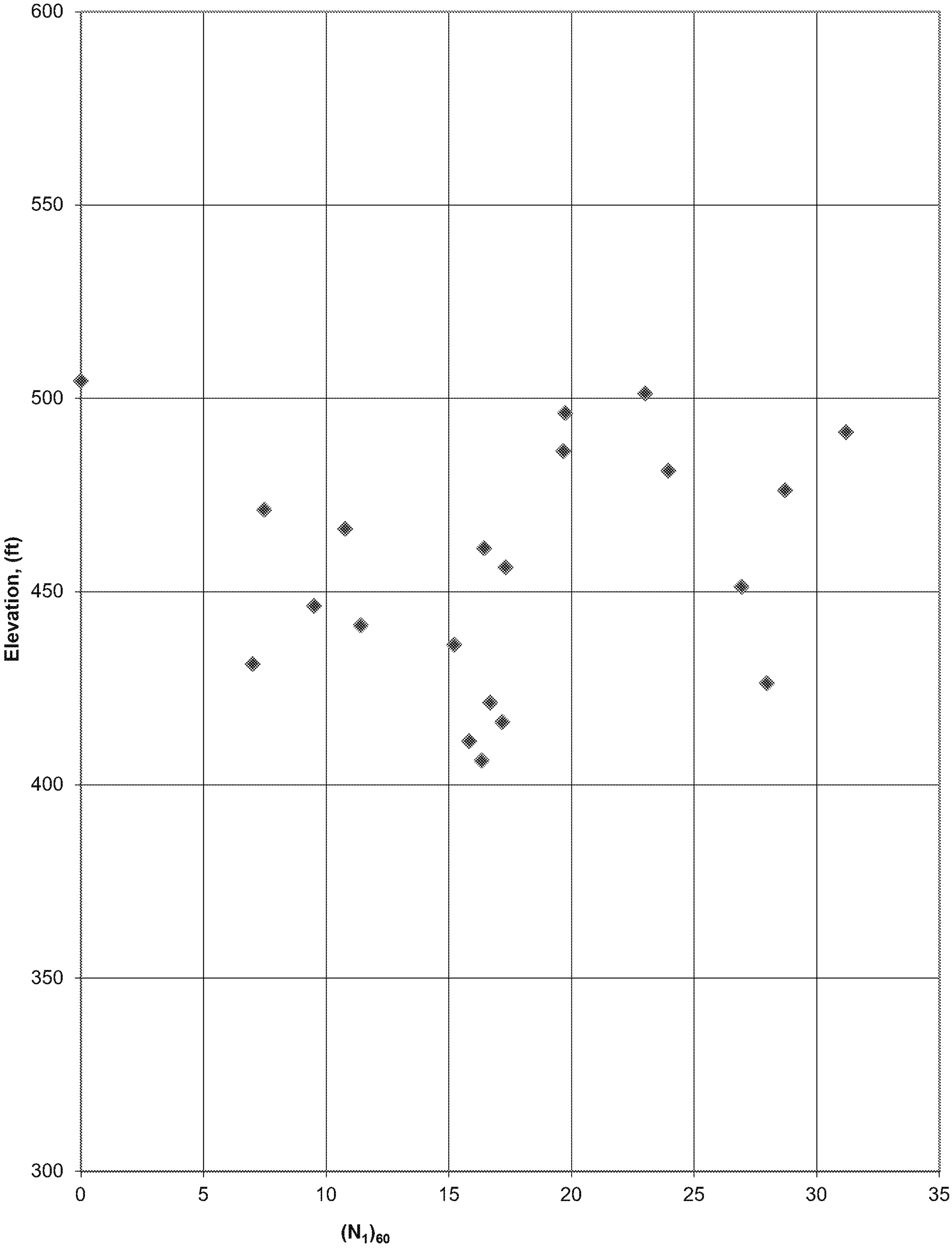
Note: A factor of safety shown as "NA" implies that the soil type is not appropriately evaluated using this methodology. This applies to soils classified as CL, CH, CL-ML and MH. These soils should be evaluated using methods for fine-grained soils. Also, "NA" implies that coarse grained soils with equivalent clean sand N-values greater than 30 are resistant to liquefaction.

Depth of Mid. Pt. of Sample (ft.)	Vert. Total Stress during EQ (tsf)	Vert. Total Stress during EQ w/ Fill (tsf)	Static Pore Pressure during EQ (tsf)	Vert. Eff. Stress during EQ (tsf)	Vert. Eff. Stress during EQ w/ Fill (tsf)	Effective All-Around Stress during EQ (psf)	Shear Modulus during EQ (ksf)			Equivalent Clean Sand N-Value				Mag. Scaling	CRR	Simplified Stress Reduction	Simplified CSR eq	Max. Shake Stress (psf)	Avg. Shake Stress (psf)	Using SHAKE Data CSR eq	FS liq	FS liq	Simplified FS liq	FS liq
z	σ_v	$\sigma_{v\,with\,fill}$	u	σ'_v	$\sigma'_{v\,with\,fill}$	σ'_m	G_{max}	Alpha I	Beta I	$(N_1)_{60cs}$	CRR7.5	Ksigma	Kalpha	Factor (Cm)	Design EQ	Coeff., r_d	Design EQ	Design EQ	Design EQ	Design EQ	Design EQ	for plot	Design EQ	for plot
	totstr-top 0.16		u-top 0.00	effstr-top 0.16																				
3.3	0.20	0.20	0.00	0.20	0.20	270.83	#NUM!	NA	NA	NA	NA	NA	NA	0.95	NA	0.994	0.055	0	0	0.000	NA	10.0	NA	10.00
8.3	0.52	0.52	0.00	0.52	0.52	687.50	#NUM!	NA	NA	NA	NA	NA	NA	0.95	NA	0.983	0.054	0	0	0.000	NA	10.0	NA	10.00
13.3	0.83	0.83	0.00	0.83	0.83	1104.17	#NUM!	NA	NA	NA	NA	NA	NA	0.95	NA	0.972	0.054	0	0	0.000	NA	10.0	NA	10.00
18.3	1.14	1.14	0.00	1.14	1.14	1520.83	#NUM!	5.00	1.20	29	NA	0.990	1.000	0.95	NA	0.961	0.053	0	0	0.000	NA	10.0	NA	10.00
23.3	1.45	1.45	0.00	1.45	1.45	1937.50	#NUM!	NA	NA	NA	NA	NA	NA	0.95	NA	0.948	0.052	0	0	0.000	NA	10.0	NA	10.00
28.3	1.77	1.77	0.00	1.77	1.77	2354.17	#NUM!	5.00	1.20	39	NA	0.909	1.000	0.95	NA	0.929	0.051	0	0	0.000	NA	10.0	NA	10.00
33.3	2.08	2.08	0.10	1.98	1.98	2635.63	#NUM!	NA	NA	NA	NA	NA	NA	0.95	NA	0.902	0.052	0	0	0.000	NA	10.0	NA	10.00
38.3	2.39	2.39	0.26	2.13	2.13	2844.30	#NUM!	5.00	1.20	18	0.191	0.935	1.000	0.95	0.169	0.866	0.054	0	0	0.000	#DIV/0!	#DIV/0!	3.4	3.36
43.3	2.70	2.70	0.41	2.29	2.29	3052.97	#NUM!	5.00	1.20	25	0.287	0.911	1.000	0.95	0.248	0.821	0.054	0	0	0.000	#DIV/0!	#DIV/0!	4.9	4.92
48.3	3.02	3.02	0.57	2.45	2.45	3261.63	#NUM!	5.00	1.20	26	0.308	0.904	1.000	0.95	0.264	0.771	0.052	0	0	0.000	#DIV/0!	#DIV/0!	5.3	5.34
53.3	3.33	3.33	0.73	2.60	2.60	3470.30	#NUM!	5.00	1.20	37	NA	0.847	1.000	0.95	NA	0.720	0.051	0	0	0.000	NA	10.0	NA	10.00
58.3	3.64	3.64	0.88	2.76	2.76	3678.97	#NUM!	5.00	1.20	16	0.175	0.915	1.000	0.95	0.152	0.674	0.049	0	0	0.000	#DIV/0!	#DIV/0!	3.3	3.28
63.3	3.95	3.95	1.04	2.92	2.92	3887.63	#NUM!	5.00	1.20	19	0.200	0.906	1.000	0.95	0.172	0.634	0.048	0	0	0.000	#DIV/0!	#DIV/0!	3.8	3.84
68.3	4.27	4.27	1.19	3.07	3.07	4096.30	#NUM!	5.00	1.20	23	0.261	0.882	1.000	0.95	0.218	0.602	0.046	0	0	0.000	#DIV/0!	#DIV/0!	5.0	5.03
73.3	4.58	4.58	1.35	3.23	3.23	4304.97	#NUM!	5.00	1.20	13	0.144	0.908	1.000	0.95	0.124	0.576	0.045	0	0	0.000	#DIV/0!	#DIV/0!	2.9	2.93
78.3	4.89	4.89	1.51	3.39	3.39	4513.63	#NUM!	5.00	1.20	39	NA	0.794	1.000	0.95	NA	0.555	0.044	0	0	0.000	NA	10.0	NA	10.00
83.3	5.20	5.20	1.66	3.54	3.54	4722.30	#NUM!	5.00	1.20	25	0.292	0.861	1.000	0.95	0.239	0.538	0.044	0	0	0.000	#DIV/0!	#DIV/0!	5.8	5.81
88.3	5.52	5.52	1.82	3.70	3.70	4930.97	#NUM!	5.00	1.20	26	0.305	0.856	1.000	0.95	0.247	0.524	0.043	0	0	0.000	#DIV/0!	#DIV/0!	6.1	6.09
93.3	5.83	5.83	1.97	3.85	3.85	5139.63	#NUM!	5.00	1.20	24	0.274	0.857	1.000	0.95	0.222	0.512	0.043	0	0	0.000	#DIV/0!	#DIV/0!	5.5	5.53
98.3	6.14	6.14	2.13	4.01	4.01	5348.30	#NUM!	NA	NA	NA	NA	NA	NA	0.95	NA	0.502	0.042	0	0	0.000	NA	10.0	NA	10.00

Clifty Creek AEP, Boring = SS3-1, Source = 0, Mw = 7.7, Event = 0, SPT Data, NCEER Method (updated per Idriss and Boulanger (2008)) with Ground Response Analysis, No Fines Correction if Zero Blowcounts



Clifty Creek AEP, Boring = SS3-1, Source = 0, Mw = 7.7, Event = 0, SPT Data, NCEER Method (updated per Idriss and Boulanger (2008)) with Ground Response Analysis, No Fines Correction if Zero Blowcounts



EQ Source: 0
a max (g): 0.085
EQ Mag (Mw): 7.7

Event (MCE, OBE, etc.): 0
EQ Motion File: 0

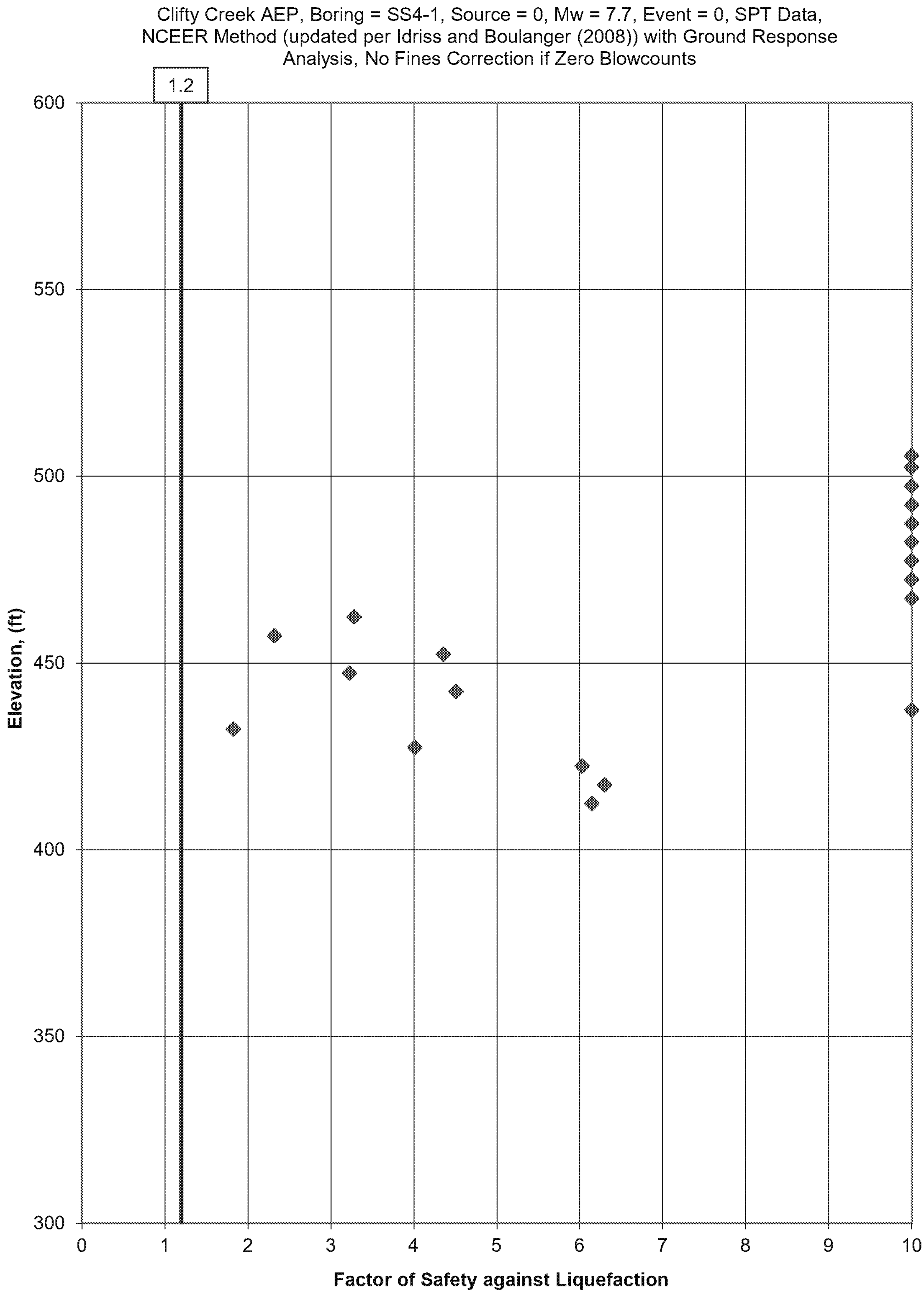
Shake Stress Curve Fit Parameters
m4: 0
m3: 0
m2: 0
m1: 0

Boring ID: **SS4-1**
Top of Fill Elevation: 505.6 ft *(if no fill, then set this equal to top of SPT hole elev.)*
Fill Height: 0.0 ft *(relative to ground surface during SPT)*
Fill Total Unit Weight: 125 pcf
Fill Total Stress: 0.00 tsf

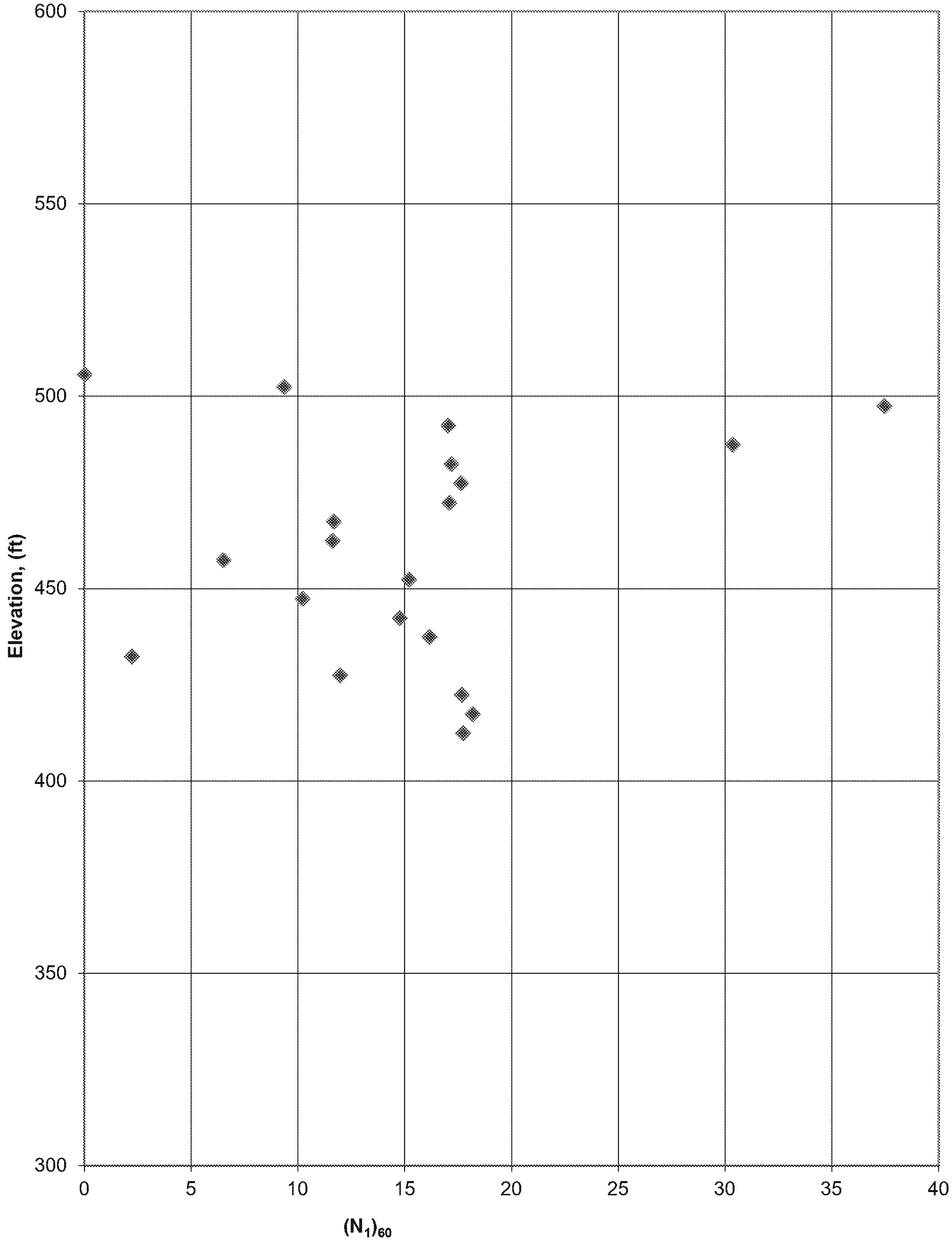
Note: A factor of safety shown as "NA" implies that the soil type is not appropriately evaluated using this methodology. This applies to soils classified as CL, CH, CL-ML and MH. These soils should be evaluated using methods for fine-grained soils. Also, "NA" implies that coarse grained soils with equivalent clean sand N-values greater than 30 are resistant to liquefaction.

totstr-top	u-top	effstr-top
0.16	0.00	0.16

Depth of Mid. Pt. of Sample (ft.) z	Vert. Total Stress during EQ (tsf) σ_v	Vert. Total Stress during EQ w/ Fill (tsf) $\sigma_{v\,with\,fill}$	Static Pore Pressure during EQ (tsf) u	Vert. Eff. Stress during EQ (tsf) σ'_v	Vert. Eff. Stress during EQ w/ Fill (tsf) $\sigma'_{v\,with\,fill}$	Effective All-Around Stress during EQ (psf) σ'_m	Shear Modulus during EQ (ksf) G_{max}	Alpha I	Beta I	Equivalent Clean Sand N-Value $(N_1)_{60cs}$	CRR7.5	Ksigma	Kalpha	Mag. Scaling Factor (Cm)	CRR Design EQ	Simplified Stress Reduction Coeff., r_d	Simplified CSR eq Design EQ	Max. Shake Stress (psf) Design EQ	Avg. Shake Stress (psf) Design EQ	Using SHAKE Data: CSR eq Design EQ	Using SHAKE Data: FS liq Design EQ	Using SHAKE Data: FS liq for plot	Simplified: FS liq Design EQ	Simplified: FS liq for plot
3.3	0.20	0.20	0.00	0.20	0.20	270.83	#NUM!	NA	NA	NA	NA	NA	NA	0.95	NA	0.994	0.055	0	0	0.000	NA	10.0	NA	10.00
8.3	0.52	0.52	0.00	0.52	0.52	687.50	#NUM!	5.00	1.20	50	NA	1.000	1.000	0.95	NA	0.983	0.054	0	0	0.000	NA	10.0	NA	10.00
13.3	0.83	0.83	0.00	0.83	0.83	1104.17	#NUM!	NA	NA	NA	NA	NA	NA	0.95	NA	0.972	0.054	0	0	0.000	NA	10.0	NA	10.00
18.3	1.14	1.14	0.00	1.14	1.14	1520.83	#NUM!	NA	NA	NA	NA	NA	NA	0.95	NA	0.961	0.053	0	0	0.000	NA	10.0	NA	10.00
23.3	1.45	1.45	0.00	1.45	1.45	1937.50	#NUM!	NA	NA	NA	NA	NA	NA	0.95	NA	0.948	0.052	0	0	0.000	NA	10.0	NA	10.00
28.3	1.77	1.77	0.13	1.63	1.63	2177.37	#NUM!	NA	NA	NA	NA	NA	NA	0.95	NA	0.929	0.055	0	0	0.000	NA	10.0	NA	10.00
33.3	2.08	2.08	0.29	1.79	1.79	2386.03	#NUM!	NA	NA	NA	NA	NA	NA	0.95	NA	0.902	0.058	0	0	0.000	NA	10.0	NA	10.00
38.3	2.39	2.39	0.44	1.95	1.95	2594.70	#NUM!	NA	NA	NA	NA	NA	NA	0.95	NA	0.866	0.059	0	0	0.000	NA	10.0	NA	10.00
43.3	2.70	2.70	0.60	2.10	2.10	2803.37	#NUM!	5.00	1.20	19	0.203	0.937	1.000	0.95	0.180	0.821	0.058	0	0	0.000	#DIV/0!	#DIV/0!	3.3	3.28
48.3	3.02	3.02	0.76	2.26	2.26	3012.03	#NUM!	5.00	1.20	13	0.139	0.940	1.000	0.95	0.124	0.771	0.057	0	0	0.000	#DIV/0!	#DIV/0!	2.3	2.32
53.3	3.33	3.33	0.91	2.42	2.42	3220.70	#NUM!	5.00	1.20	23	0.261	0.908	1.000	0.95	0.225	0.720	0.055	0	0	0.000	#DIV/0!	#DIV/0!	4.4	4.36
58.3	3.64	3.64	1.07	2.57	2.57	3429.37	#NUM!	5.00	1.20	17	0.184	0.918	1.000	0.95	0.160	0.674	0.053	0	0	0.000	#DIV/0!	#DIV/0!	3.2	3.22
63.3	3.95	3.95	1.22	2.73	2.73	3638.03	#NUM!	5.00	1.20	23	0.253	0.899	1.000	0.95	0.216	0.634	0.051	0	0	0.000	#DIV/0!	#DIV/0!	4.5	4.51
68.3	4.27	4.27	1.38	2.89	2.89	3846.70	#NUM!	NA	NA	NA	NA	NA	NA	0.95	NA	0.602	0.049	0	0	0.000	NA	10.0	NA	10.00
73.3	4.58	4.58	1.54	3.04	3.04	4055.37	#NUM!	5.00	1.20	8	0.093	0.931	1.000	0.95	0.082	0.576	0.048	0	0	0.000	#DIV/0!	#DIV/0!	1.8	1.83
78.3	4.89	4.89	1.69	3.20	3.20	4264.03	#NUM!	5.00	1.20	19	0.208	0.898	1.000	0.95	0.177	0.555	0.047	0	0	0.000	#DIV/0!	#DIV/0!	4.0	4.01
83.3	5.20	5.20	1.85	3.35	3.35	4472.70	#NUM!	5.00	1.20	26	0.318	0.867	1.000	0.95	0.261	0.538	0.046	0	0	0.000	#DIV/0!	#DIV/0!	6.0	6.03
88.3	5.52	5.52	2.00	3.51	3.51	4681.37	#NUM!	5.00	1.20	27	0.334	0.852	1.000	0.95	0.270	0.524	0.045	0	0	0.000	#DIV/0!	#DIV/0!	6.3	6.30
93.3	5.83	5.83	2.16	3.67	3.67	4890.03	#NUM!	5.00	1.20	26	0.320	0.857	1.000	0.95	0.260	0.512	0.045	0	0	0.000	#DIV/0!	#DIV/0!	6.1	6.15


Clifty Creek AEP, Boring = SS4-1, Source = 0, Mw = 7.7, Event = 0, SPT Data, NCEER Method (updated per Idriss and Boulanger (2008)) with Ground Response Analysis, No Fines Correction if Zero Blowcounts
1.2
600
550
500
450
400
350
300
Elevation, (ft)
0
1
2
3
4
5
6
7
8
9
10
Factor of Safety against Liquefaction

Clifty Creek AEP, Boring = SS4-1, Source = 0, Mw = 7.7, Event = 0, SPT Data, NCEER Method (updated per Idriss and Boulanger (2008)) with Ground Response Analysis, No Fines Correction if Zero Blowcounts



APPENDIX I

STABILITY ANALYSIS

BOILER SLAG POND DAM: 2015 CCR MANDATE

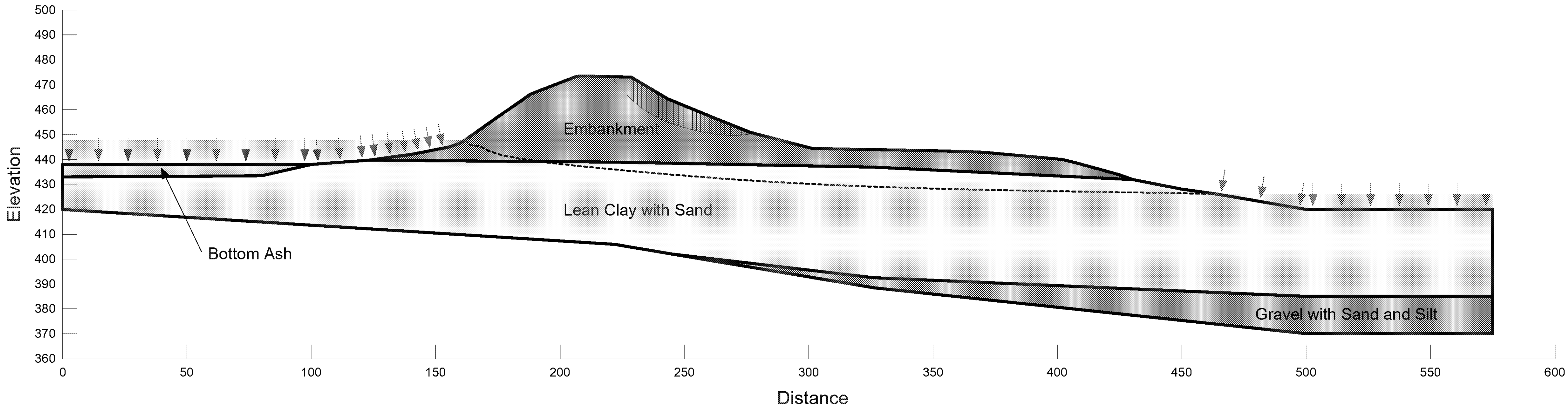
Factor of Safety = 2.30

American Electric Power (AEP)
Clifty Creek West Boiler Slag Pond Dam
Madison, Indiana
CCR Mandate

Material	Unit Weight (pcf)	Drained Strength Parameters Phi (deg.)	Cohesion (psf)
Embankment (Drained)	130	33.2	165
Lean Clay with Sand (Drained)	119	27.2	160
Gravel With Silt and Sand (Drained)	130	35	0
Bottom Ash (Drained)	115	28	0

L01_Normal Pool, Downstream Slope Failure
Normal Pool Elevation: 448 Feet
Drained Static Strengths
Incipient Motion in the Downstream Direction
Section A-A'

Note: The results of the analysis shown here are based on available subsurface information, laboratory test results and approximate soil properties. The drawing depicts approximate subsurface conditions based on historical drawings or specific borings at the time of drilling.
No warranties can be made regarding the continuity of subsurface conditions.



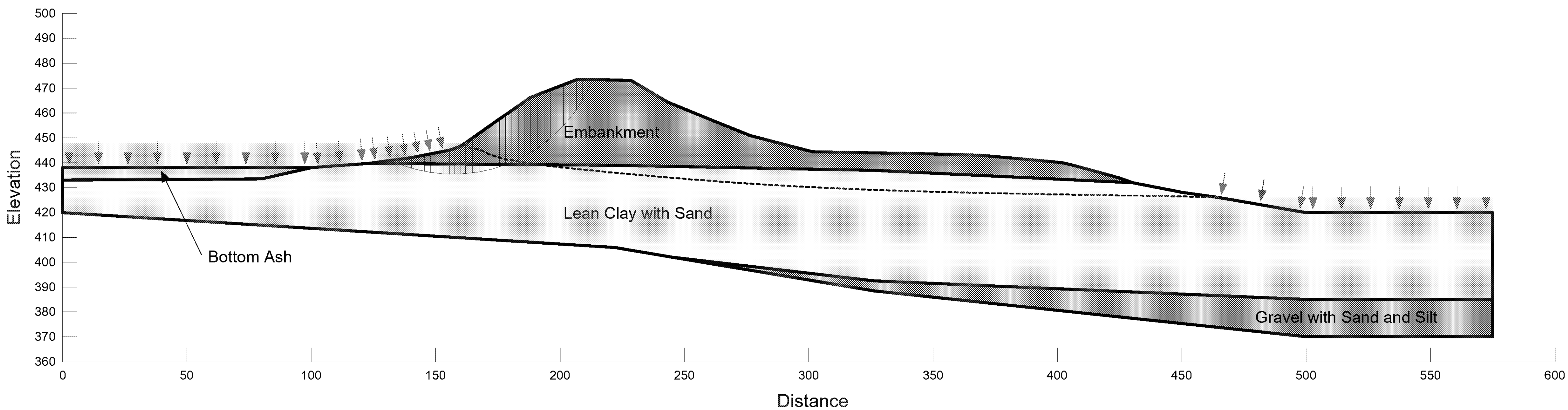
Factor of Safety = 1.88

American Electric Power (AEP)
Clifty Creek West Boiler Slag Pond Dam
Madison, Indiana
CCR Mandate

Material	Unit Weight (pcf)	Drained Strength Parameters Phi (deg.)	Cohesion (psf)
Embankment (Drained)	130	33.2	165
Lean Clay with Sand (Drained)	119	27.2	160
Gravel With Silt and Sand (Drained)	130	35	0
Bottom Ash (Drained)	115	28	0

L02_Normal Pool, Upstream Slope Failure
Normal Pool Elevation: 448 Feet
Drained Static Strengths
Incipient Motion in the Upstream Direction
Section A-A'

Note: The results of the analysis shown here are based on available subsurface information, laboratory test results and approximate soil properties. The drawing depicts approximate subsurface conditions based on historical drawings or specific borings at the time of drilling.
No warranties can be made regarding the continuity of subsurface conditions.



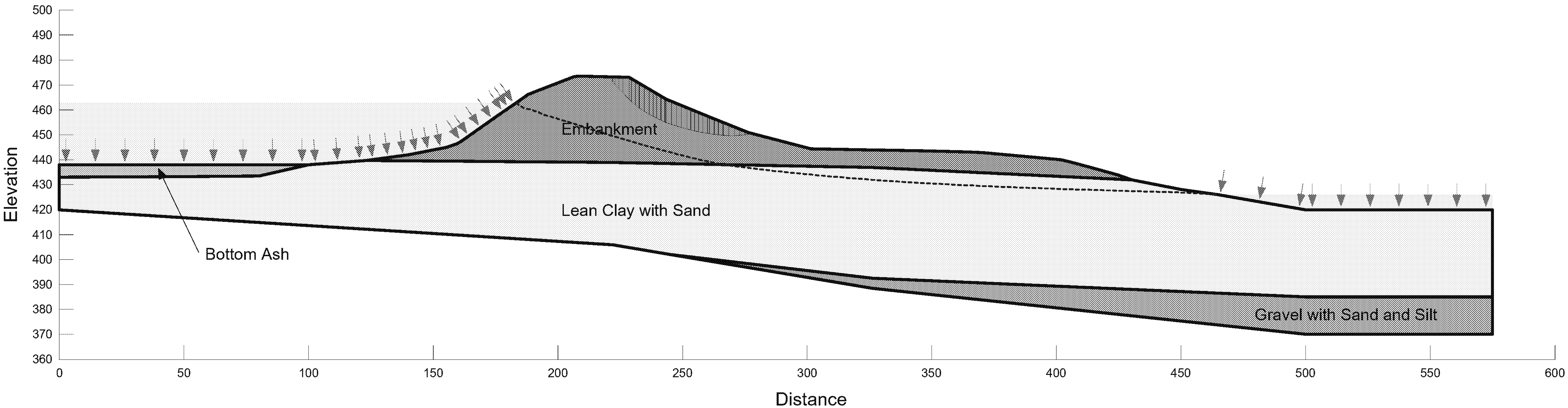
Factor of Safety = 2.30

American Electric Power (AEP)
Clifty Creek West Boiler Slag Pond Dam
Madison, Indiana
CCR Mandate

L03_50% PMF Pool, Downstream Slope Failure
50% PMF Pool Elevation: 462.8 Feet
Drained Static Strengths
Incipient Motion in the Downstream Direction
Section A-A'

Material	Unit Weight (pcf)	Drained Strength Parameters Phi (deg.)	Cohesion (psf)
Embankment (Drained)	130	33.2	165
Lean Clay with Sand (Drained)	119	27.2	160
Gravel With Silt and Sand (Drained)	130	35	0
Bottom Ash (Drained)	115	28	0

Note: The results of the analysis shown here are based on available subsurface information, laboratory test results and approximate soil properties. The drawing depicts approximate subsurface conditions based on historical drawings or specific borings at the time of drilling.
No warranties can be made regarding the continuity of subsurface conditions.



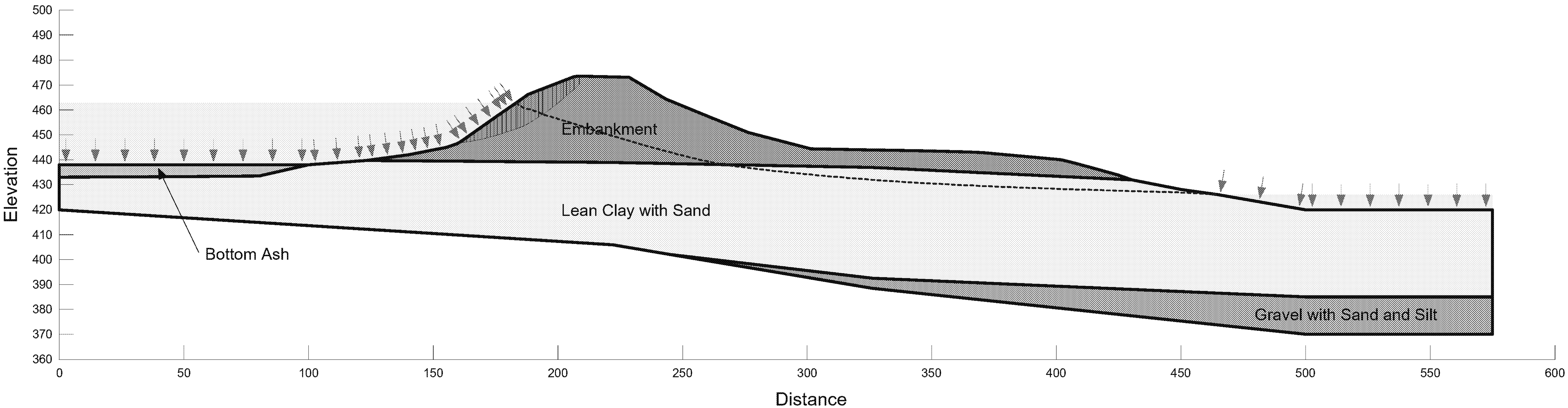
Factor of Safety = 2.13

American Electric Power (AEP)
Clifty Creek West Boiler Slag Pond Dam
Madison, Indiana
CCR Mandate

Material	Unit Weight (pcf)	Drained Strength Parameters Phi (deg.)	Cohesion (psf)
Embankment (Drained)	130	33.2	165
Lean Clay with Sand (Drained)	119	27.2	160
Gravel With Silt and Sand (Drained)	130	35	0
Bottom Ash (Drained)	115	28	0

L04_50% PMF Pool, Upstream Slope Failure
50% PMF Pool Elevation: 462.8 Feet
Drained Static Strengths
Incipient Motion in the Upstream Direction
Section A-A'

Note: The results of the analysis shown here are based on available subsurface information, laboratory test results and approximate soil properties. The drawing depicts approximate subsurface conditions based on historical drawings or specific borings at the time of drilling.
No warranties can be made regarding the continuity of subsurface conditions.



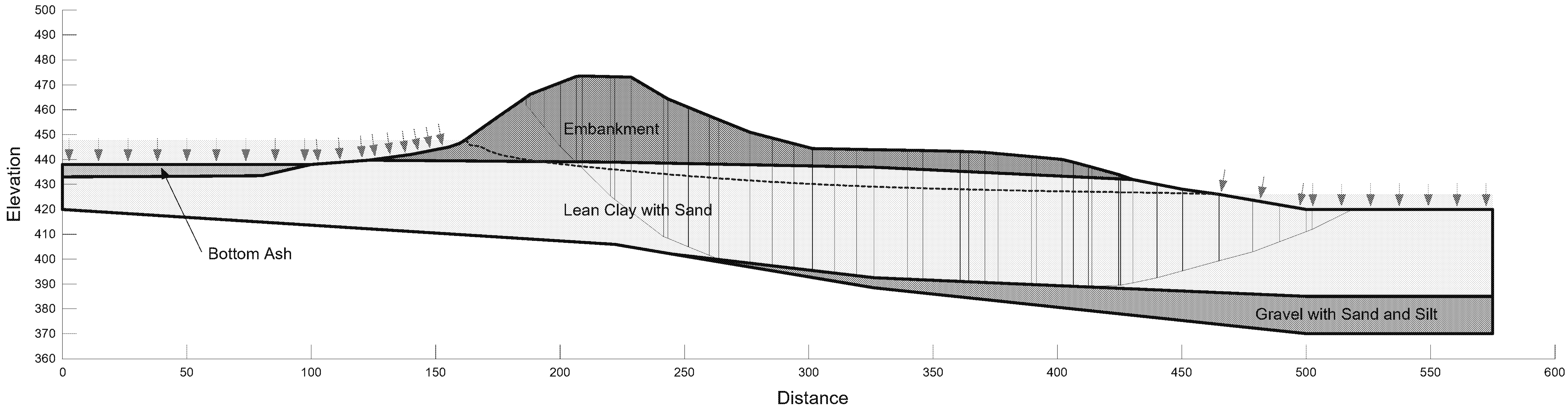
Factor of Safety = 1.35

American Electric Power (AEP)
Clifty Creek West Boiler Slag Pond Dam
Madison, Indiana
CCR Mandate

L05_Seismic_Normal Pool, Downstream Slope Failure
Normal Pool Elevation: 448 Feet
Undrained Static Strengths
Incipient Motion in the Downstream Direction
Horizontal Acc: 0.085g
Section A-A'

Material	Unit Weight (pcf)	Drained Strength Parameters Phi (deg.)	Drained Strength Parameters Cohesion (psf)	Undrained Strength Parameters Phi (deg.)	Undrained Strength Parameters Cohesion (psf)
Embankment (Seismic Undrained)	130	33.2	165	13	600
Lean Clay with Sand (Seismic Undrained)	119	27.2	160	5	1200
Gravel With Silt and Sand (Seismic Undrained)	130	35	0	35	0
Bottom Ash (Seismic Undrained)	115	28	0	28	0

Note: The results of the analysis shown here are based on available subsurface information, laboratory test results and approximate soil properties. The drawing depicts approximate subsurface conditions based on historical drawings or specific borings at the time of drilling.
No warranties can be made regarding the continuity of subsurface conditions.



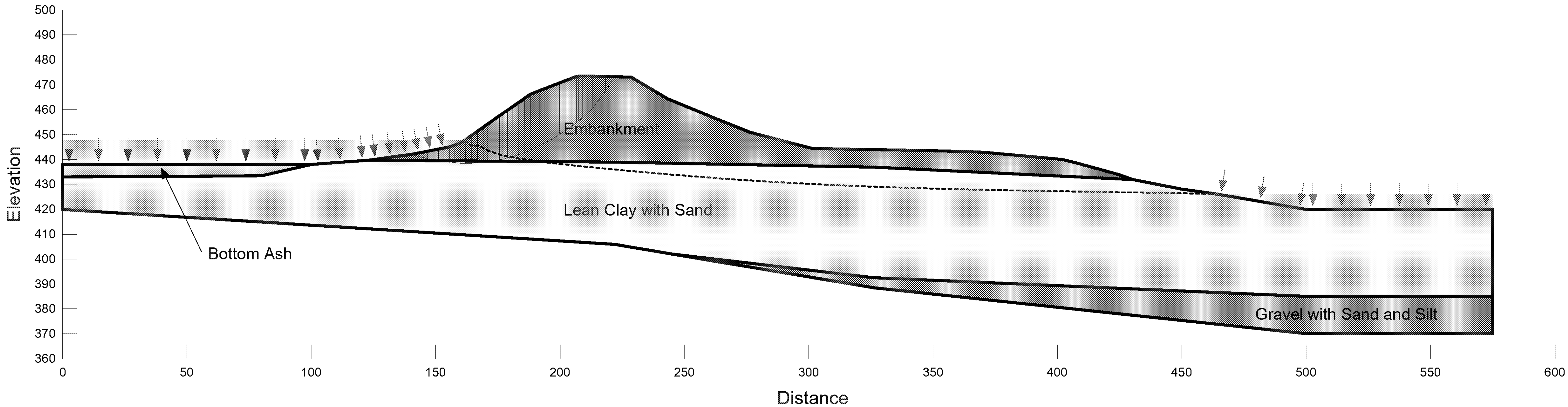
Factor of Safety = 1.34

American Electric Power (AEP)
Clifty Creek West Boiler Slag Pond Dam
Madison, Indiana
CCR Mandate

L06_Seismic_Normal Pool, Upstream Slope Failure
Normal Pool Elevation: 448 Feet
Undrained Static Strengths
Incipient Motion in the Upstream Direction
Horizontal Acc: 0.085g
Section A-A'

Material	Unit Weight (pcf)	Drained Strength Parameters Phi (deg.)	Drained Strength Parameters Cohesion (psf)	Undrained Strength Parameters Phi (deg.)	Undrained Strength Parameters Cohesion (psf)
Embankment (Seismic Undrained)	130	33.2	165	13	600
Lean Clay with Sand (Seismic Undrained)	119	27.2	160	5	1200
Gravel With Silt and Sand (Seismic Undrained)	130	35	0	35	0
Bottom Ash (Seismic Undrained)	115	28	0	28	0

Note: The results of the analysis shown here are based on available subsurface information, laboratory test results and approximate soil properties. The drawing depicts approximate subsurface conditions based on historical drawings or specific borings at the time of drilling.
No warranties can be made regarding the continuity of subsurface conditions.



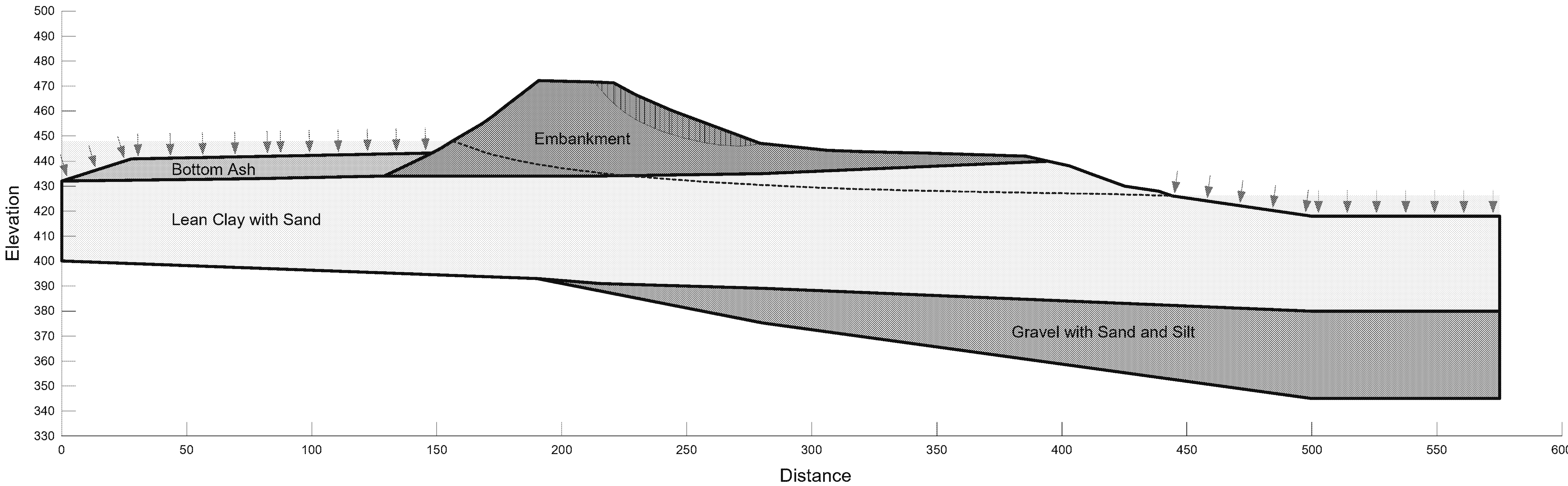
Factor of Safety = 2.44

American Electric Power (AEP)
Clifty Creek West Boiler Slag Pond Dam
Madison, Indiana
CCR Mandate

L01_Normal Pool, Downstream Slope Failure
Normal Pool Elevation: 448 Feet
Drained Static Strengths
Incipient Motion in the Downstream Direction
Section B-B'

Note: The results of the analysis shown here are based on available subsurface information, laboratory test results and approximate soil properties. The drawing depicts approximate subsurface conditions based on historical drawings or specific borings at the time of drilling.
No warranties can be made regarding the continuity of subsurface conditions.

Material	Unit Weight (pcf)	Drained Strength Parameters Phi (deg.)	Cohesion (psf)
Embankment (Drained)	130	33.2	165
Lean Clay With Sand (Drained)	119	27.2	160
Gravel With Silt And Sand (Drained)	130	35	0
Bottom Ash (Drained)	115	28	0



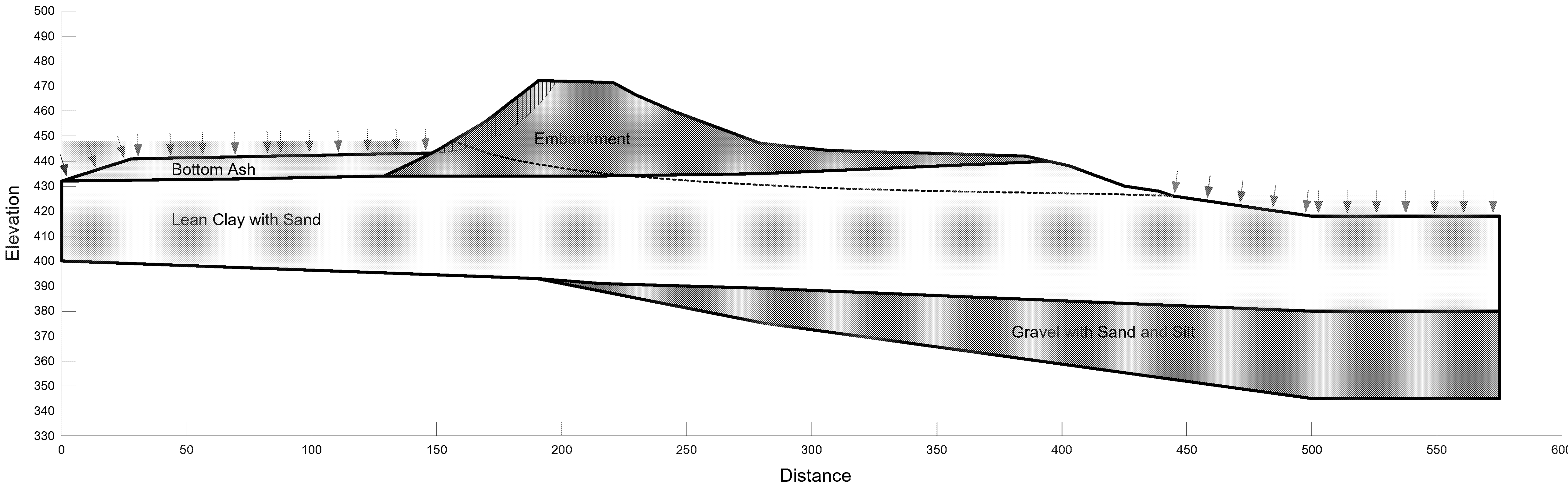
Factor of Safety = 1.63

American Electric Power (AEP)
Clifty Creek West Boiler Slag Pond Dam
Madison, Indiana
CCR Mandate

L02_Normal Pool, Upstream Slope Failure
Normal Pool Elevation: 448 Feet
Drained Static Strengths
Incipient Motion in the Upstream Direction
Section B-B'

Note: The results of the analysis shown here are based on available subsurface information, laboratory test results and approximate soil properties. The drawing depicts approximate subsurface conditions based on historical drawings or specific borings at the time of drilling.
No warranties can be made regarding the continuity of subsurface conditions.

Material	Unit Weight (pcf)	Drained Strength Parameters Phi (deg.)	Cohesion (psf)
Embankment (Drained)	130	33.2	165
Lean Clay With Sand (Drained)	119	27.2	160
Gravel With Silt And Sand (Drained)	130	35	0
Bottom Ash (Drained)	115	28	0



ED_006570_00010329-00666

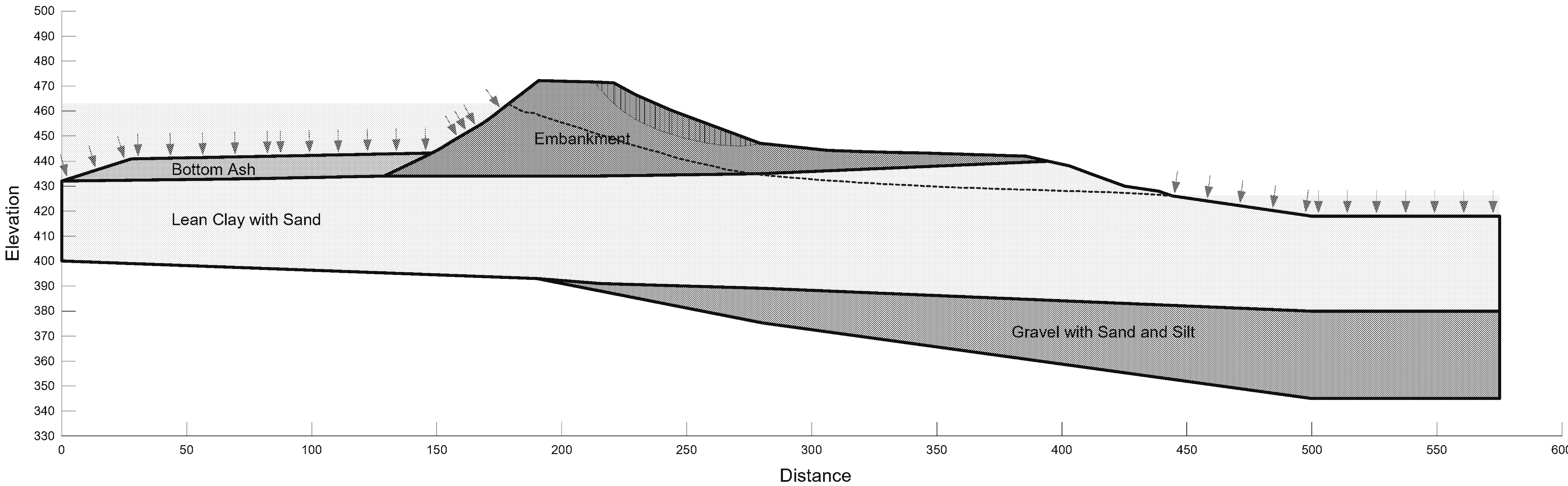
Factor of Safety = 2.44

American Electric Power (AEP)
Clifty Creek West Boiler Slag Pond Dam
Madison, Indiana
CCR Mandate

L03_50% PMF Pool, Downstream Slope Failure
50% PMF Pool Elevation: 462.8 Feet
Drained Static Strengths
Incipient Motion in the Downstream Direction
Section B-B'

Material	Unit Weight (pcf)	**Drained Strength Parameters** Phi (deg.)	Cohesion (psf)
Embankment (Drained)	130	33.2	165
Lean Clay With Sand (Drained)	119	27.2	160
Gravel With Silt And Sand (Drained)	130	35	0
Bottom Ash (Drained)	115	28	0

Note: The results of the analysis shown here are based on available subsurface information, laboratory test results and approximate soil properties. The drawing depicts approximate subsurface conditions based on historical drawings or specific borings at the time of drilling.
No warranties can be made regarding the continuity of subsurface conditions.



ED_006570_00010329-00667

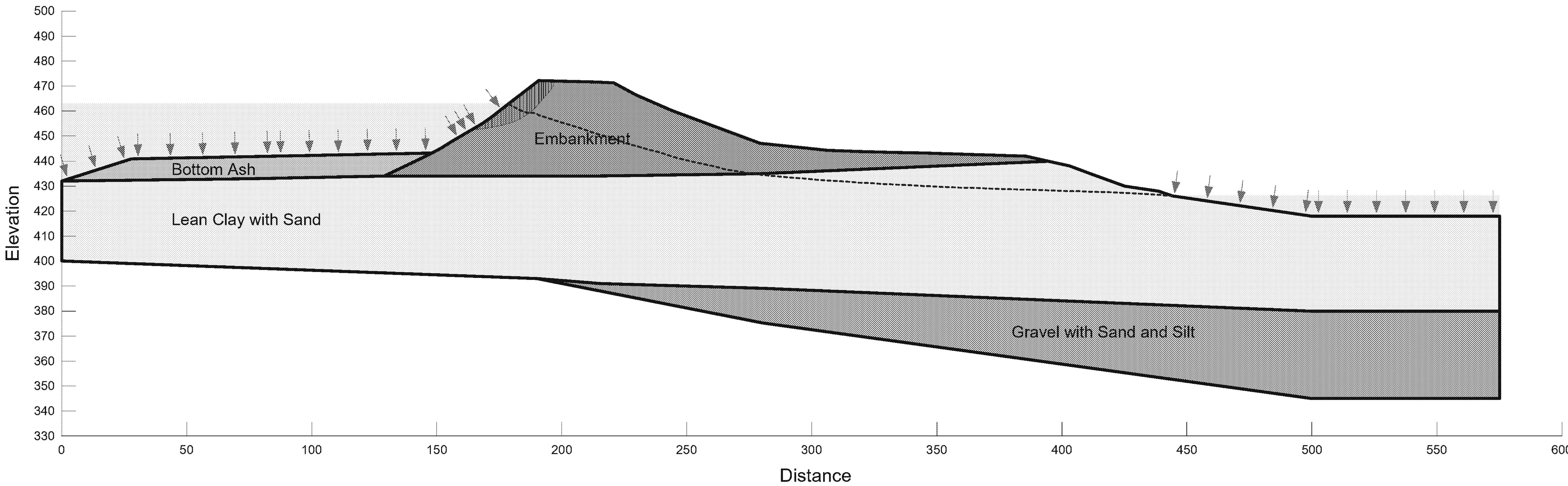
Factor of Safety = 1.95

American Electric Power (AEP)
Clifty Creek West Boiler Slag Pond Dam
Madison, Indiana
CCR Mandate

L04_50% PMF Pool, Upstream Slope Failure
50% PMF Pool Elevation: 462.8 Feet
Drained Static Strengths
Incipient Motion in the Upstream Direction
Section B-B'

Note: The results of the analysis shown here are based on available subsurface information, laboratory test results and approximate soil properties. The drawing depicts approximate subsurface conditions based on historical drawings or specific borings at the time of drilling.
No warranties can be made regarding the continuity of subsurface conditions.

Material	Unit Weight (pcf)	Drained Strength Parameters Phi (deg.)	Cohesion (psf)
Embankment (Drained)	130	33.2	165
Lean Clay With Sand (Drained)	119	27.2	160
Gravel With Silt And Sand (Drained)	130	35	0
Bottom Ash (Drained)	115	28	0



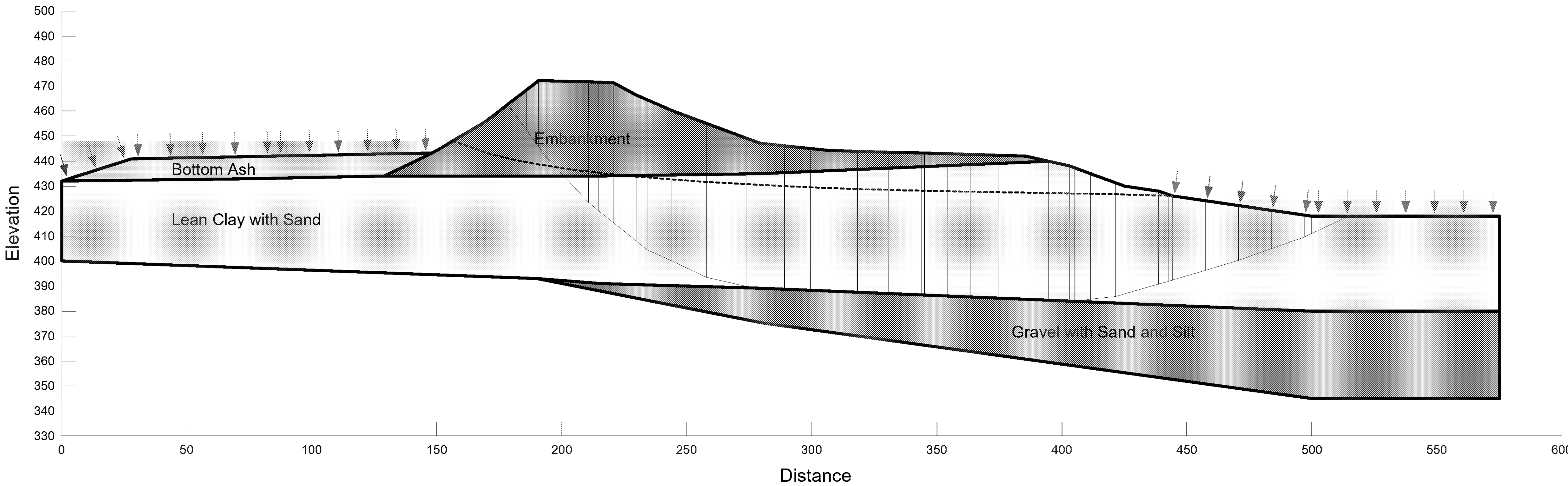
Factor of Safety = 1.30

American Electric Power (AEP)
Clifty Creek West Boiler Slag Pond Dam
Madison, Indiana
CCR Mandate

L05_Seismic_Normal Pool, Downstream Slope Failure
Normal Pool Elevation: 448 Feet
Undrained Static Strengths
Incipient Motion in the Downstream Direction
Horizontal Acc: 0.085g
Section B-B'

Material	Unit Weight (pcf)	**Drained Strength Parameters** Phi (deg.)	Cohesion (psf)	**Undrained Strength Parameters** Phi (deg.)	Cohesion (psf)
Embankment (Seismic Undrained)	130	33.2	165	13	600
Lean Clay With Sand (Seismic Undrained)	119	27.2	160	5	1200
Gravel With Silt And Sand (Seismic Undrained)	130	35	0	35	0
Bottom Ash (Seismic Undrained)	115	28	0	28	0

Note: The results of the analysis shown here are based on available subsurface information, laboratory test results and approximate soil properties. The drawing depicts approximate subsurface conditions based on historical drawings or specific borings at the time of drilling. No warranties can be made regarding the continuity of subsurface conditions.



ED_006570_00010329-00669

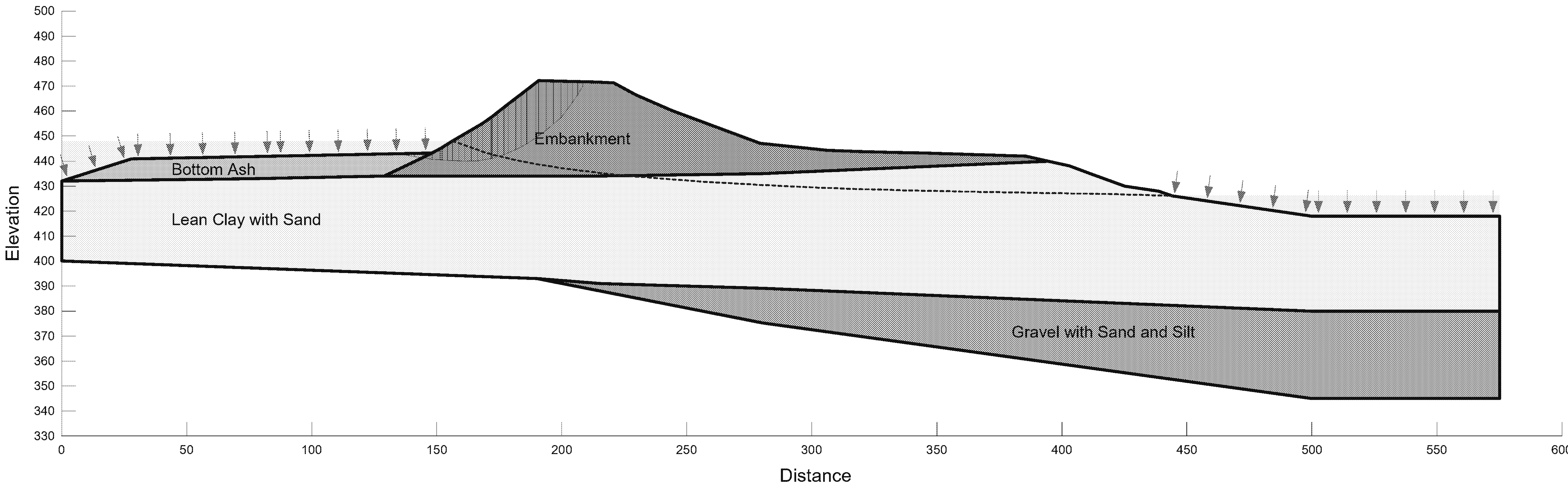
Factor of Safety = 1.30

American Electric Power (AEP)
Clifty Creek West Boiler Slag Pond Dam
Madison, Indiana
CCR Mandate

L06_Seismic_Normal Pool, Upstream Slope Failure
Normal Pool Elevation: 448 Feet
Undrained Static Strengths
Incipient Motion in the Upstream Direction
Horizontal Acc: 0.085g
Section B-B'

Material	Unit Weight (pcf)	**Drained Strength Parameters** Phi (deg.)	Cohesion (psf)	**Undrained Strength Parameters** Phi (deg.)	Cohesion (psf)
Embankment (Seismic Undrained)	130	33.2	165	13	600
Lean Clay With Sand (Seismic Undrained)	119	27.2	160	5	1200
Gravel With Silt And Sand (Seismic Undrained)	130	35	0	35	0
Bottom Ash (Seismic Undrained)	115	28	0	28	0

Note: The results of the analysis shown here are based on available subsurface information, laboratory test results and approximate soil properties. The drawing depicts approximate subsurface conditions based on historical drawings or specific borings at the time of drilling.
No warranties can be made regarding the continuity of subsurface conditions.



ED_006570_00010329-00670

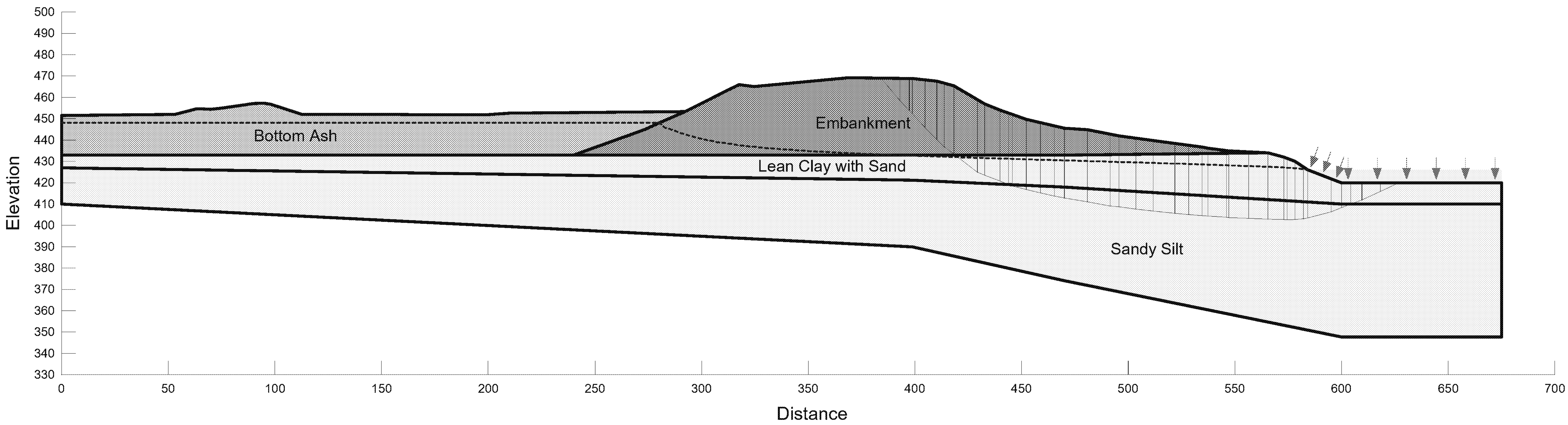
American Electric Power (AEP)
Clifty Creek West Boiler Slag Pond Dam
Madison, Indiana
CCR Mandate

Factor of Safety = 2.30

L01_Normal Pool, Downstream Slope Failure
Normal Pool Elevation: 448 Feet
Drained Static Strengths
Incipient Motion in the Downstream Direction
Section C-C'

Note: The results of the analysis shown here are based on available subsurface information, laboratory test results and approximate soil properties. The drawing depicts approximate subsurface conditions based on historical drawings or specific borings at the time of drilling.
No warranties can be made regarding the continuity of subsurface conditions.

		Drained Strength Parameters	
Material	Unit Weight (pcf)	Phi (deg.)	Cohesion (psf)
Embankment (Drained)	130	33.2	165
Lean Clay with Sand (Drained)	119	27.2	160
Sandy Silt (Drained)	130	30	0
Bottom Ash (Drained)	115	28	0



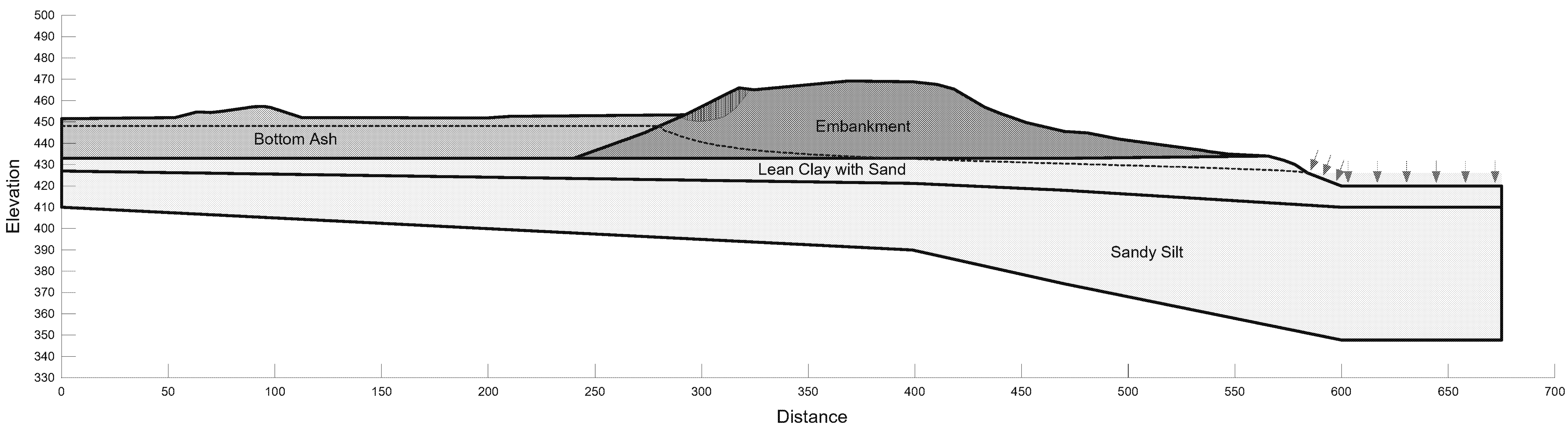
American Electric Power (AEP)
Clifty Creek West Boiler Slag Pond Dam
Madison, Indiana
CCR Mandate

Factor of Safety = 2.73

L02_Normal Pool, Upstream Slope Failure
Normal Pool Elevation: 448 Feet
Drained Static Strengths
Incipient Motion in the Upstream Direction
Section C-C'

Material	Unit Weight (pcf)	Drained Strength Parameters Phi (deg.)	Cohesion (psf)
Embankment (Drained)	130	33.2	165
Lean Clay with Sand (Drained)	119	27.2	160
Sandy Silt (Drained)	130	30	0
Bottom Ash (Drained)	115	28	0

Note: The results of the analysis shown here are based on available subsurface information, laboratory test results and approximate soil properties. The drawing depicts approximate subsurface conditions based on historical drawings or specific borings at the time of drilling.
No warranties can be made regarding the continuity of subsurface conditions.



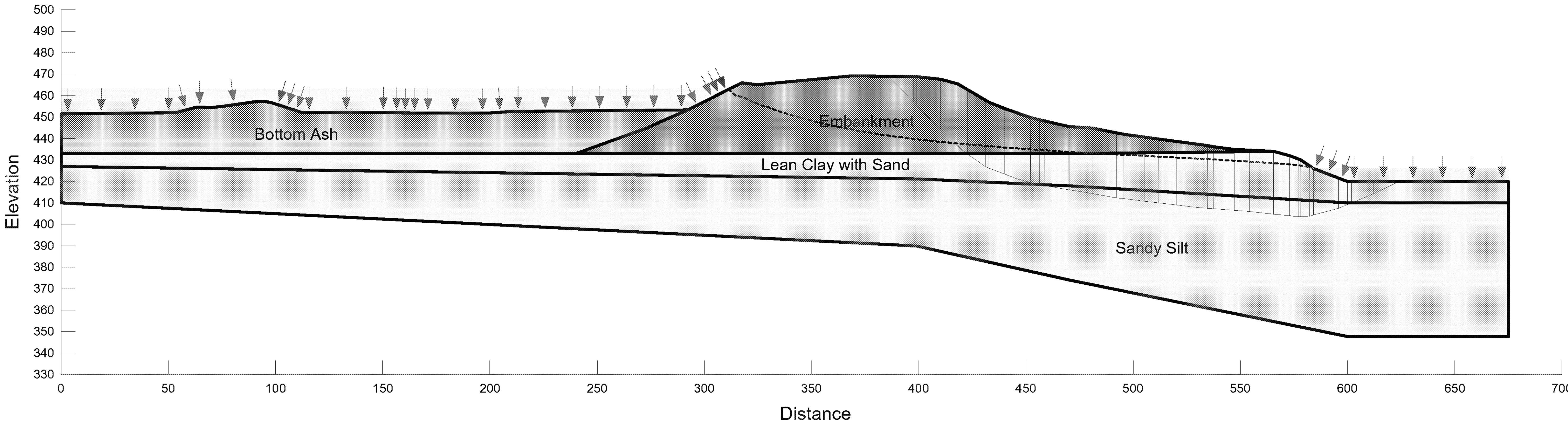
American Electric Power (AEP)
Clifty Creek West Boiler Slag Pond Dam
Madison, Indiana
CCR Mandate

Factor of Safety = 2.18

L03_50% PMF Pool, Downstream Slope Failure
50% PMF Pool Elevation: 462.8 Feet
Drained Static Strengths
Incipient Motion in the Downstream Direction
Section C-C'

Note: The results of the analysis shown here are based on available subsurface information, laboratory test results and approximate soil properties. The drawing depicts approximate subsurface conditions based on historical drawings or specific borings at the time of drilling.
No warranties can be made regarding the continuity of subsurface conditions.

		Drained Strength Parameters	
Material	Unit Weight (pcf)	Phi (deg.)	Cohesion (psf)
Embankment (Drained)	130	33.2	165
Lean Clay with Sand (Drained)	119	27.2	160
Sandy Silt (Drained)	130	30	0
Bottom Ash (Drained)	115	28	0



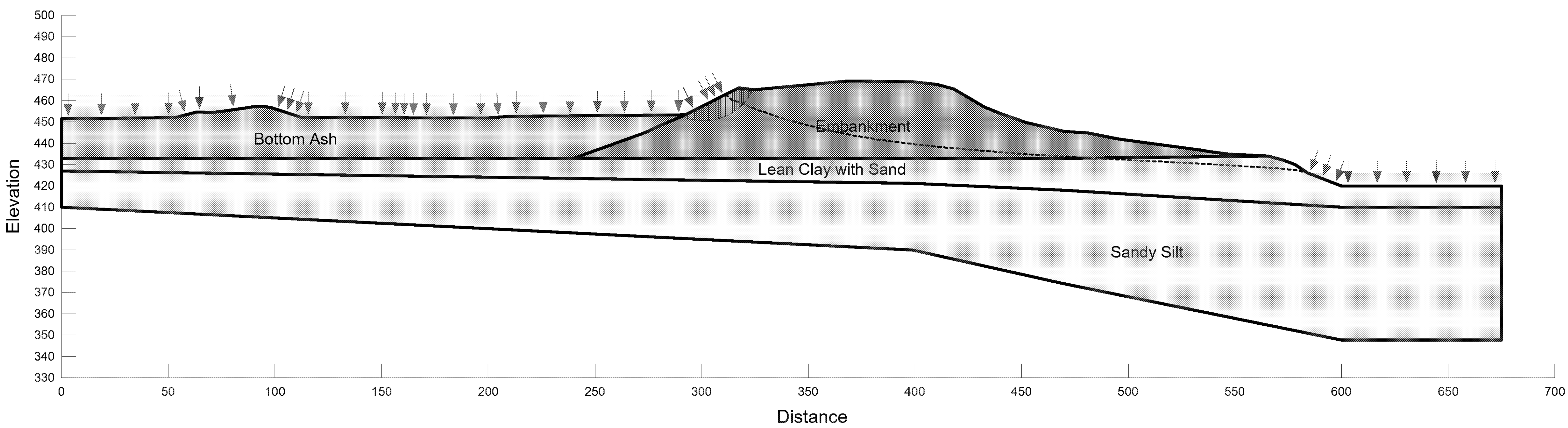
Factor of Safety = 3.88

American Electric Power (AEP)
Clifty Creek West Boiler Slag Pond Dam
Madison, Indiana
CCR Mandate

L04_50% PMF Pool, Upstream Slope Failure
50% PMF Pool Elevation: 462.8 Feet
Drained Static Strengths
Incipient Motion in the Upstream Direction
Section C-C'

Note: The results of the analysis shown here are based on available subsurface information, laboratory test results and approximate soil properties. The drawing depicts approximate subsurface conditions based on historical drawings or specific borings at the time of drilling.
No warranties can be made regarding the continuity of subsurface conditions.

Material	Unit Weight (pcf)	Drained Strength Parameters Phi (deg.)	Cohesion (psf)
Embankment (Drained)	130	33.2	165
Lean Clay with Sand (Drained)	119	27.2	160
Sandy Silt (Drained)	130	30	0
Bottom Ash (Drained)	115	28	0



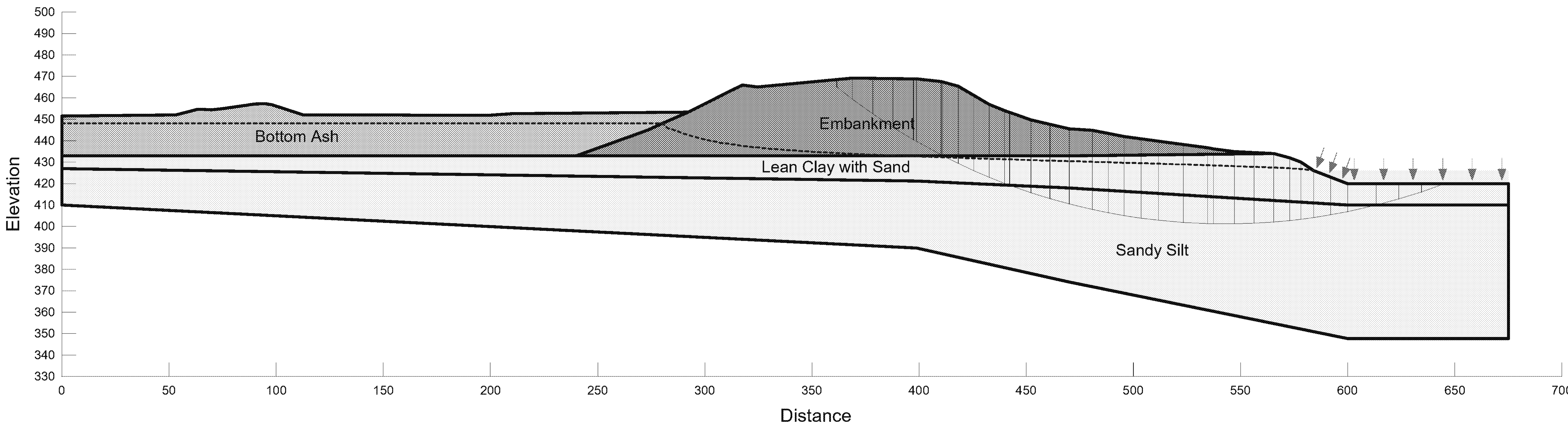
American Electric Power (AEP)
Clifty Creek West Boiler Slag Pond Dam
Madison, Indiana
CCR Mandate

Factor of Safety = 1.53

L05_Seismic_Normal Pool, Downstream Slope Failure
Normal Pool Elevation: 448 Feet
Undrained Static Strengths
Incipient Motion in the Downstream Direction
Horizontal Acc: 0.085g
Section C-C'

Material	Unit Weight (pcf)	Drained Strength Parameters Phi (deg.)	Drained Strength Parameters Cohesion (psf)	Undrained Strength Parameters Phi (deg.)	Undrained Strength Parameters Cohesion (psf)
Embankment (Seismic Undrained)	130	33.2	165	13	600
Lean Clay with Sand (Seismic Undrained)	119	27.2	160	5	1200
Sandy Silt (Seismic Undrained)	130	30	0	30	0
Bottom Ash (Seismic Undrained)	115	28	0	28	0

Note: The results of the analysis shown here are based on available subsurface information, laboratory test results and approximate soil properties. The drawing depicts approximate subsurface conditions based on historical drawings or specific borings at the time of drilling.
No warranties can be made regarding the continuity of subsurface conditions.



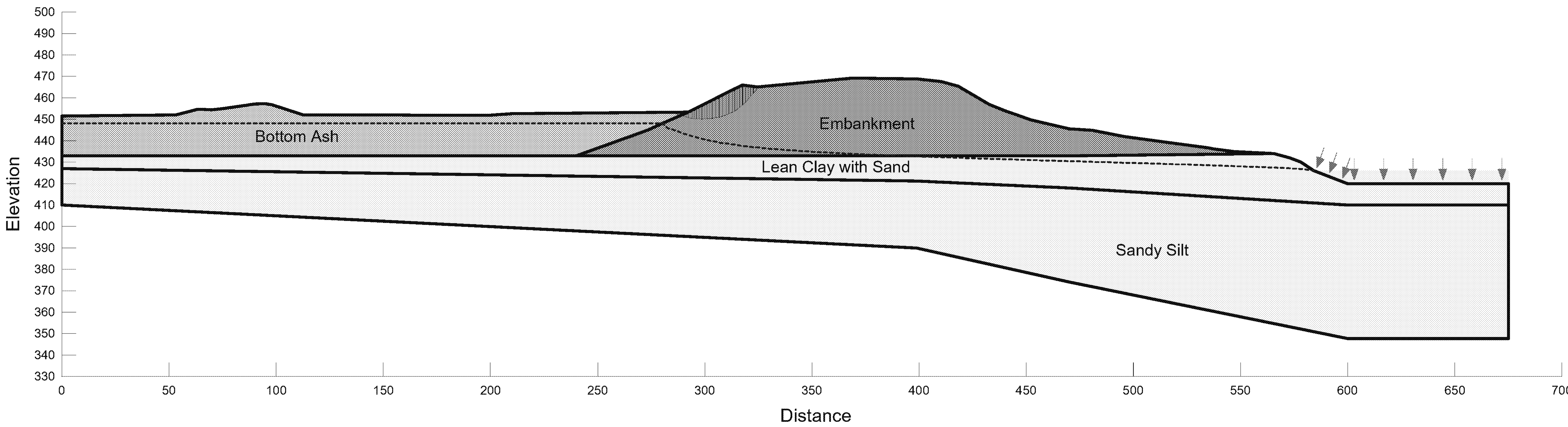
American Electric Power (AEP)
Clifty Creek West Boiler Slag Pond Dam
Madison, Indiana
CCR Mandate

Factor of Safety = 2.25

L06_Seismic_Normal Pool, Upstream Slope Failure
Normal Pool Elevation: 448 Feet
Undrained Static Strengths
Incipient Motion in the Upstream Direction
Horizontal Acc: 0.085g
Section C-C'

Material	Unit Weight (pcf)	Drained Strength Parameters Phi (deg.)	Drained Strength Parameters Cohesion (psf)	Undrained Strength Parameters Phi (deg.)	Undrained Strength Parameters Cohesion (psf)
Embankment (Seismic Undrained)	130	33.2	165	13	600
Lean Clay with Sand (Seismic Undrained)	119	27.2	160	5	1200
Sandy Silt (Seismic Undrained)	130	30	0	30	0
Bottom Ash (Seismic Undrained)	115	28	0	28	0

Note: The results of the analysis shown here are based on available subsurface information, laboratory test results and approximate soil properties. The drawing depicts approximate subsurface conditions based on historical drawings or specific borings at the time of drilling.
No warranties can be made regarding the continuity of subsurface conditions.



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LANDFILL RUNOFF COLLECTION POND: 2015 CCR MANDATE

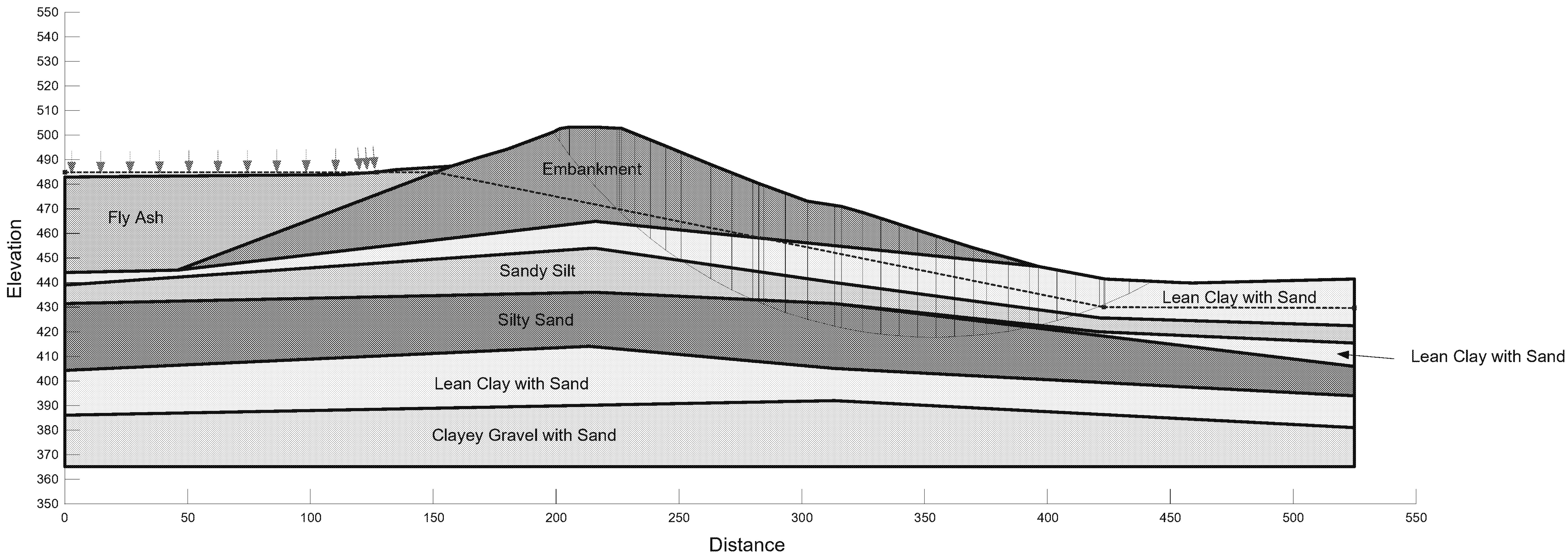
American Electric Power (AEP)
Clifty Creek Landfill Runoff Collection Pond Dam
Madison, Indiana
CCR Mandate

Factor of Safety = 1.85

L01_Normal Pool, Downstream Slope Failure
Normal Pool Elevation: 485 Feet
Drained Static Strengths
Incipient Motion in the Downstream Direction
Section D-D'

Note: The results of the analysis shown here are based on available subsurface information, laboratory test results and approximate soil properties. The drawing depicts approximate subsurface conditions based on historical drawings or specific borings at the time of drilling.
No warranties can be made regarding the continuity of subsurface conditions.

Material	Unit Weight (pcf)	Drained Strength Parameters Phi (deg.)	Cohesion (psf)
Embankment (Drained)	129	27.5	198
Lean Clay with Sand (Drained)	127	28	206
Sandy Silt (Drained)	125	30	0
Silty Sand (Drained)	94	30	0
Clayey Gravel with Sand (Drained)	130	35	0
Fly Ash (Drained)	115	25	0



ED_006570_00010329-00678

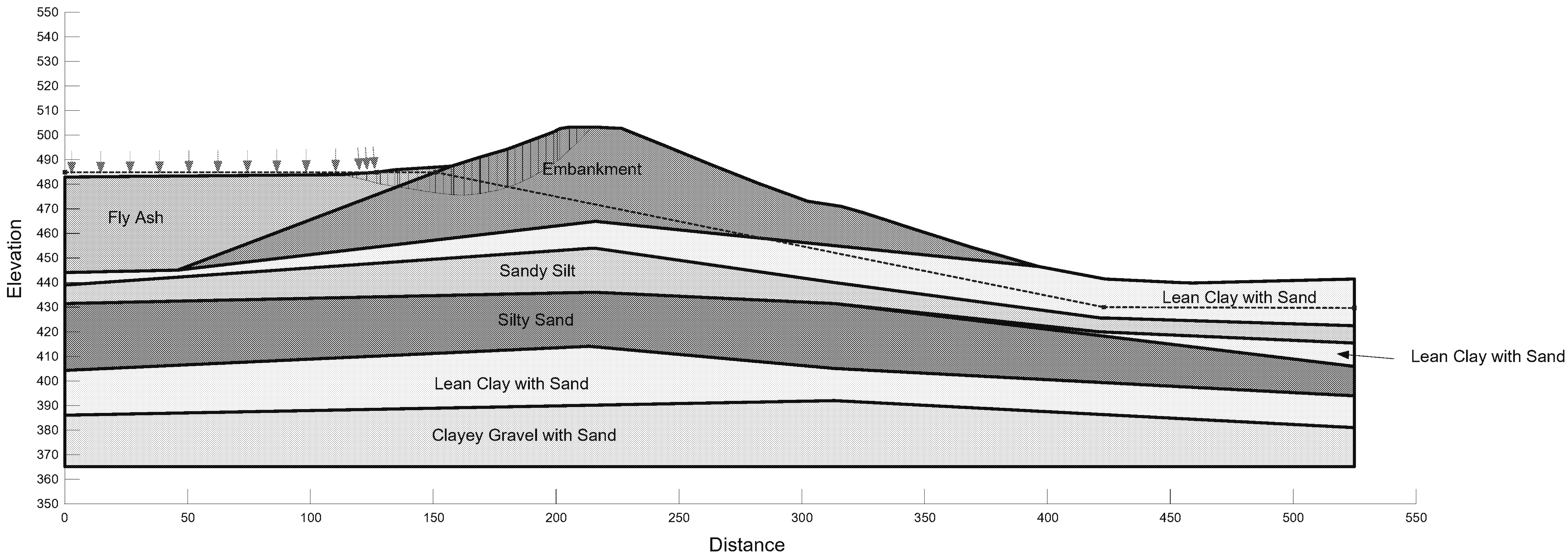
American Electric Power (AEP)
Clifty Creek Landfill Runoff Collection Pond Dam
Madison, Indiana
CCR Mandate

Factor of Safety = 2.73

L02_Normal Pool, Upstream Slope Failure
Normal Pool Elevation: 485 Feet
Drained Static Strengths
Incipient Motion in the Upstream Direction
Section D-D'

Note: The results of the analysis shown here are based on available subsurface information, laboratory test results and approximate soil properties. The drawing depicts approximate subsurface conditions based on historical drawings or specific borings at the time of drilling.
No warranties can be made regarding the continuity of subsurface conditions.

Material	Unit Weight (pcf)	Drained Strength Parameters Phi (deg.)	Cohesion (psf)
Embankment (Drained)	129	27.5	198
Lean Clay with Sand (Drained)	127	28	206
Sandy Silt (Drained)	125	30	0
Silty Sand (Drained)	94	30	0
Clayey Gravel with Sand (Drained)	130	35	0
Fly Ash (Drained)	115	25	0



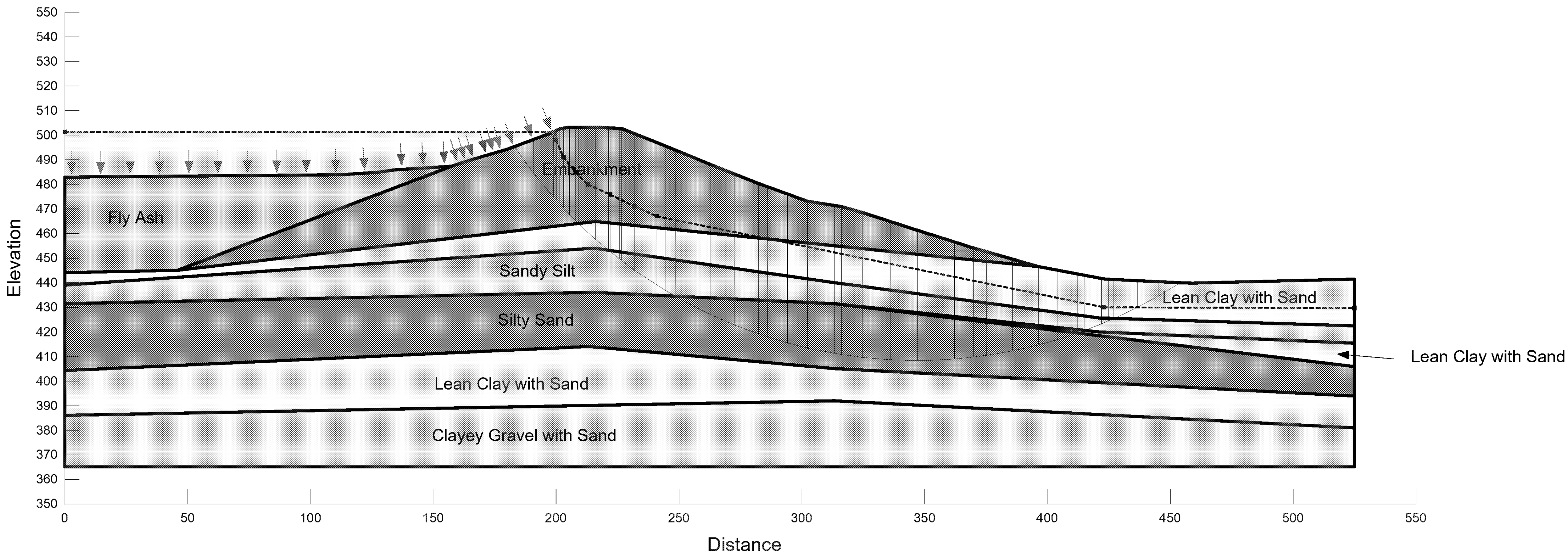
American Electric Power (AEP)
Clifty Creek Landfill Runoff Collection Pond Dam
Madison, Indiana
CCR Mandate

Factor of Safety = 1.81

L03_PMF Pool, Downstream Slope Failure
PMF Pool Elevation: 501.4 Feet
Drained Static Strengths
Incipient Motion in the Downstream Direction
Section D-D'

Note: The results of the analysis shown here are based on available subsurface information, laboratory test results and approximate soil properties. The drawing depicts approximate subsurface conditions based on historical drawings or specific borings at the time of drilling.
No warranties can be made regarding the continuity of subsurface conditions.

Material	Unit Weight (pcf)	Drained Strength Parameters Phi (deg.)	Cohesion (psf)
Embankment (Drained)	129	27.5	198
Lean Clay with Sand (Drained)	127	28	206
Sandy Silt (Drained)	125	30	0
Silty Sand (Drained)	94	30	0
Clayey Gravel with Sand (Drained)	130	35	0
Fly Ash (Drained)	115	25	0



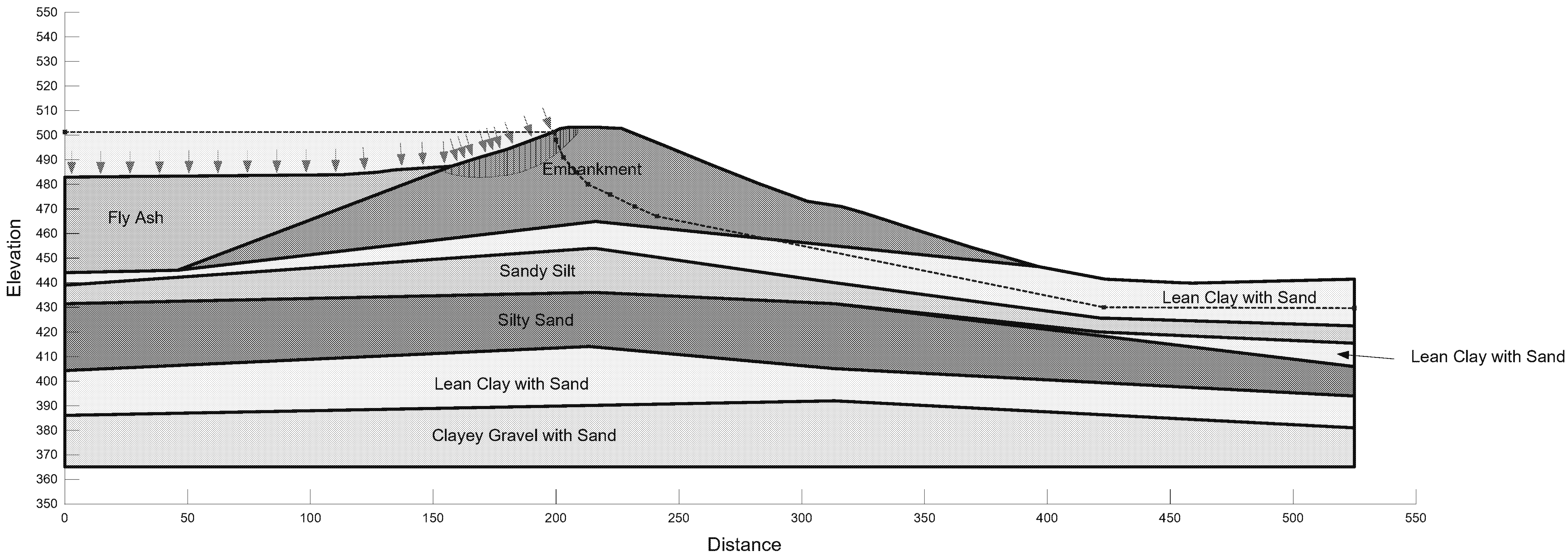
American Electric Power (AEP)
Clifty Creek Landfill Runoff Collection Pond Dam
Madison, Indiana
CCR Mandate

Factor of Safety = 3.47

L04_PMF Pool, Upstream Slope Failure
PMF Pool Elevation: 501.4 Feet
Drained Static Strengths
Incipient Motion in the Upstream Direction
Section D-D'

Note: The results of the analysis shown here are based on available subsurface information, laboratory test results and approximate soil properties. The drawing depicts approximate subsurface conditions based on historical drawings or specific borings at the time of drilling.
No warranties can be made regarding the continuity of subsurface conditions.

Material	Unit Weight (pcf)	Drained Strength Parameters Phi (deg.)	Cohesion (psf)
Embankment (Drained)	129	27.5	198
Lean Clay with Sand (Drained)	127	28	206
Sandy Silt (Drained)	125	30	0
Silty Sand (Drained)	94	30	0
Clayey Gravel with Sand (Drained)	130	35	0
Fly Ash (Drained)	115	25	0



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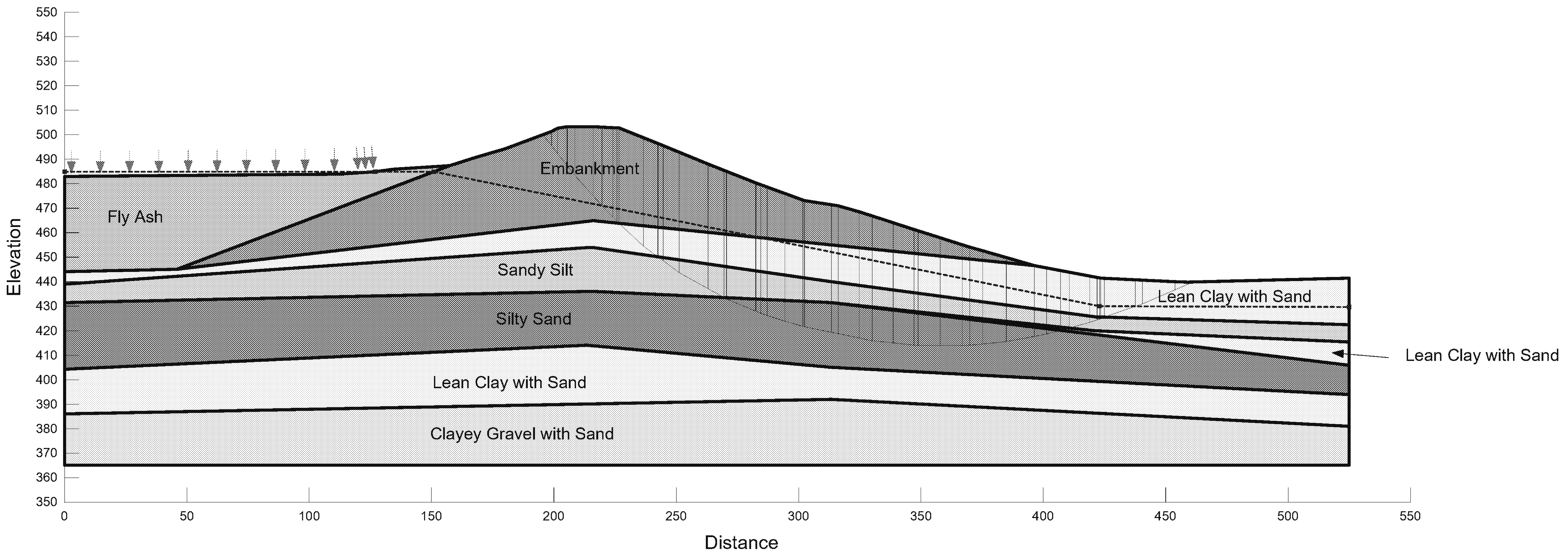
American Electric Power (AEP)
Clifty Creek Landfill Runoff Collection Pond Dam
Madison, Indiana
CCR Mandate

L05_Seismic_Normal Pool, Downstream Slope Failure
Normal Pool Elevation: 485 Feet
Undrained Static Strengths
Incipient Motion in the Downstream Direction
Horizontal Acc: 0.085g
Section D-D'

Note: The results of the analysis shown here are based on available subsurface information, laboratory test results and approximate soil properties. The drawing depicts approximate subsurface conditions based on historical drawings or specific borings at the time of drilling.
No warranties can be made regarding the continuity of subsurface conditions.

Factor of Safety = 1.42

Material	Unit Weight (pcf)	Drained Strength Parameters: Phi (deg.)	Drained Strength Parameters: Cohesion (psf)	Undrained Strength Parameters: Phi (deg.)	Undrained Strength Parameters: Cohesion (psf)
Embankment (Seismic Undrained)	129	27.5	198	21	1400
Lean Clay with Sand (Seismic Undrained)	127	28	206	17	1200
Sandy Silt (Seismic Undrained)	125	30	0	30	0
Silty Sand (Seismic Undrained)	94	30	0	30	0
Clayey Gravel with Sand (Seismic Undrained)	130	35	0	35	0
Fly Ash (Seismic Undrained)	115	25	0	25	0



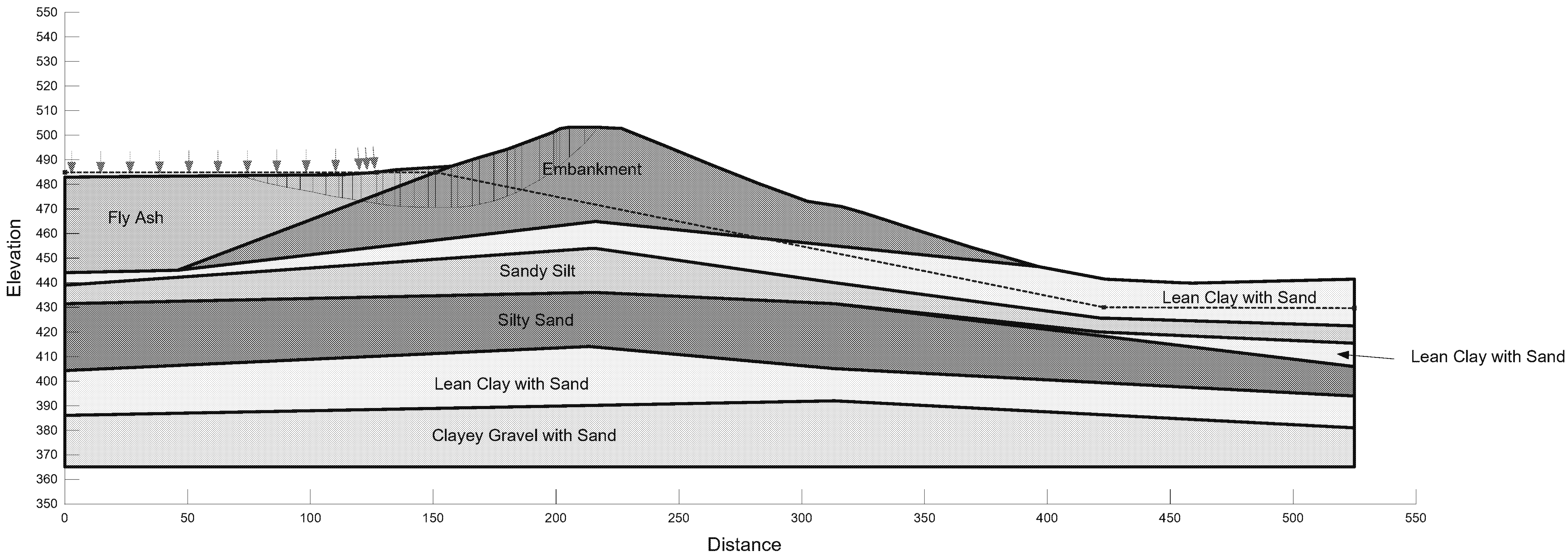
American Electric Power (AEP)
Clifty Creek Landfill Runoff Collection Pond Dam
Madison, Indiana
CCR Mandate

L06_Seismic_Normal Pool, Upstream Slope Failure
Normal Pool Elevation: 485 Feet
Undrained Static Strengths
Incipient Motion in the Upstream Direction
Horizontal Acc: 0.085g
Section D-D'

Note: The results of the analysis shown here are based on available subsurface information, laboratory test results and approximate soil properties. The drawing depicts approximate subsurface conditions based on historical drawings or specific borings at the time of drilling. No warranties can be made regarding the continuity of subsurface conditions.

Factor of Safety = 1.94

Material	Unit Weight (pcf)	**Drained Strength Parameters** Phi (deg.)	Cohesion (psf)	**Undrained Strength Parameters** Phi (deg.)	Cohesion (psf)
Embankment (Seismic Undrained)	129	27.5	198	21	1400
Lean Clay with Sand (Seismic Undrained)	127	28	206	17	1200
Sandy Silt (Seismic Undrained)	125	30	0	30	0
Silty Sand (Seismic Undrained)	94	30	0	30	0
Clayey Gravel with Sand (Seismic Undrained)	130	35	0	35	0
Fly Ash (Seismic Undrained)	115	25	0	25	0



ED_006570_00010329-00683

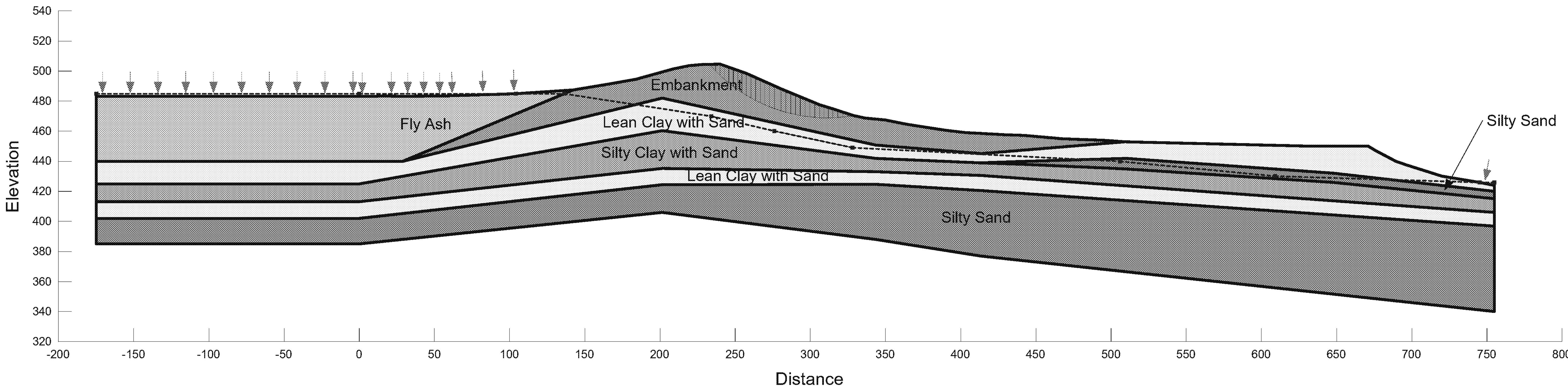
American Electric Power (AEP)
Clifty Creek Landfill Runoff Collection Pond Dam
Madison, Indiana
CCR Mandate

Factor of Safety = 1.99

L01_Normal Pool, Downstream Crest Loss
Normal Pool Elevation: 485 Feet
Drained Static Strengths
Incipient Motion in the Downstream Direction
Section E-E'

Note: The results of the analysis shown here are based on available subsurface information, laboratory test results and approximate soil properties. The drawing depicts approximate subsurface conditions based on historical drawings or specific borings at the time of drilling.
No warranties can be made regarding the continuity of subsurface conditions.

Material	Unit Weight (pcf)	**Drained Strength Parameters** Phi (deg.)	Cohesion (psf)
Embankment (Drained)	129	27.5	198
Lean Clay with Sand (Drained)	127	28	206
Silty Sand (Drained)	94	30	0
Fly Ash (Drained)	115	25	0
Silty Clay with Sand (Drained)	118	34	152



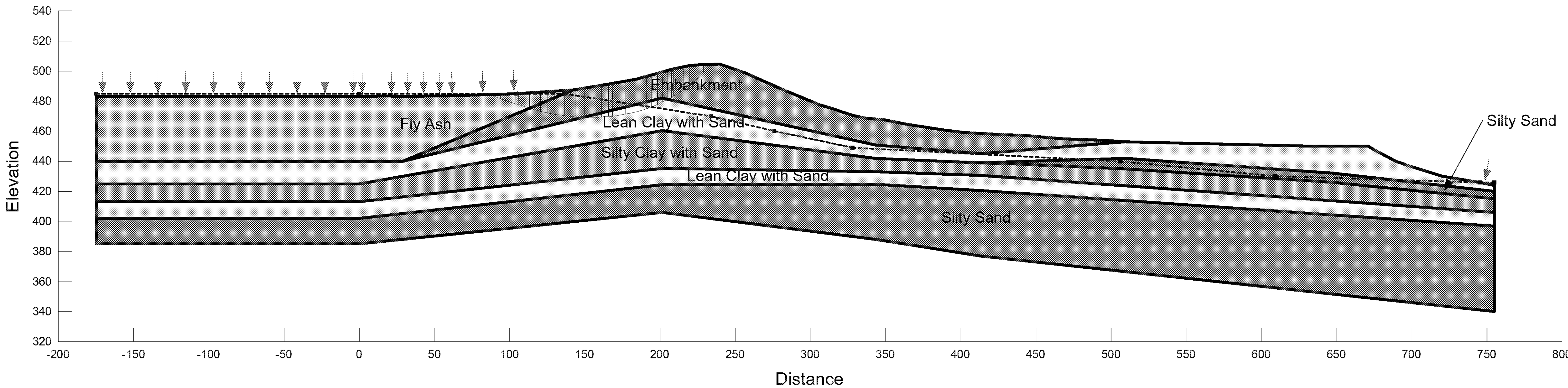
American Electric Power (AEP)
Clifty Creek Landfill Runoff Collection Pond Dam
Madison, Indiana
CCR Mandate

Factor of Safety = 3.51

L02_Normal Pool, Upstream Crest Loss
Normal Pool Elevation: 485 Feet
Drained Static Strengths
Incipient Motion in the Downstream Direction
Section E-E'

Note: The results of the analysis shown here are based on available subsurface information, laboratory test results and approximate soil properties. The drawing depicts approximate subsurface conditions based on historical drawings or specific borings at the time of drilling.
No warranties can be made regarding the continuity of subsurface conditions.

Material	Unit Weight (pcf)	Drained Strength Parameters Phi (deg.)	Cohesion (psf)
Embankment (Drained)	129	27.5	198
Lean Clay with Sand (Drained)	127	28	206
Silty Sand (Drained)	94	30	0
Fly Ash (Drained)	115	25	0
Silty Clay with Sand (Drained)	118	34	152



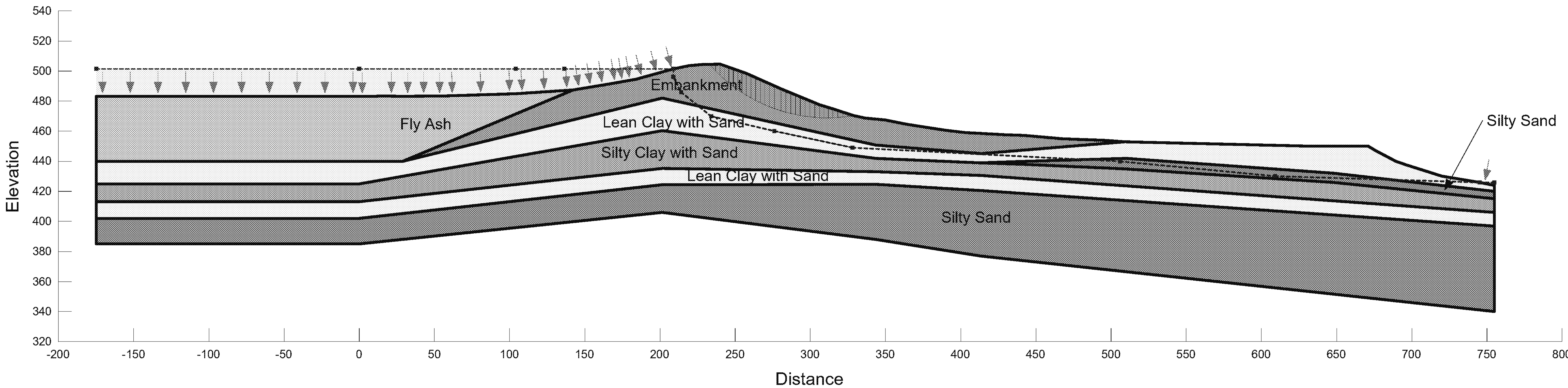
American Electric Power (AEP)
Clifty Creek Landfill Runoff Collection Pond Dam
Madison, Indiana
CCR Mandate

Factor of Safety = 1.99

L03_PMF Pool, Downstream Crest Loss
PMF Pool Elevation: 501.4 Feet
Drained Static Strengths
Incipient Motion in the Downstream Direction
Section E-E'

Note: The results of the analysis shown here are based on available subsurface information, laboratory test results and approximate soil properties. The drawing depicts approximate subsurface conditions based on historical drawings or specific borings at the time of drilling.
No warranties can be made regarding the continuity of subsurface conditions.

Material	Unit Weight (pcf)	**Drained Strength Parameters** Phi (deg.)	Cohesion (psf)
Embankment (Drained)	129	27.5	198
Lean Clay with Sand (Drained)	127	28	206
Silty Sand (Drained)	94	30	0
Fly Ash (Drained)	115	25	0
Silty Clay with Sand (Drained)	118	34	152



ED_006570_00010329-00686

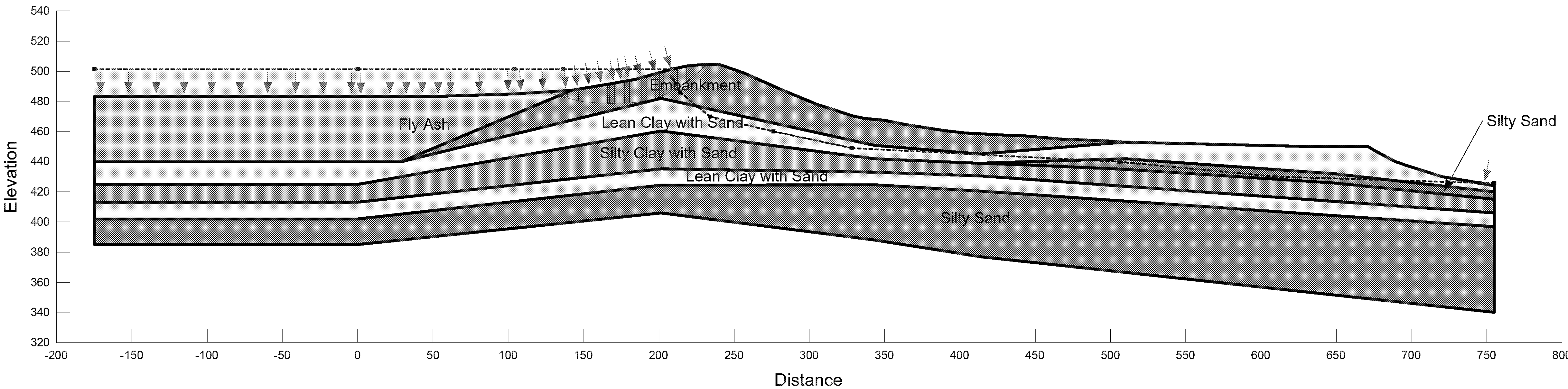
American Electric Power (AEP)
Clifty Creek Landfill Runoff Collection Pond Dam
Madison, Indiana
CCR Mandate

Factor of Safety = 4.51

L04_PMF Pool, Upstream Crest Loss
PMF Pool Elevation: 501.4 Feet
Drained Static Strengths
Incipient Motion in the Downstream Direction
Section E-E'

Note: The results of the analysis shown here are based on available subsurface information, laboratory test results and approximate soil properties. The drawing depicts approximate subsurface conditions based on historical drawings or specific borings at the time of drilling.
No warranties can be made regarding the continuity of subsurface conditions.

Material	Unit Weight (pcf)	**Drained Strength Parameters** Phi (deg.)	Cohesion (psf)
Embankment (Drained)	129	27.5	198
Lean Clay with Sand (Drained)	127	28	206
Silty Sand (Drained)	94	30	0
Fly Ash (Drained)	115	25	0
Silty Clay with Sand (Drained)	118	34	152



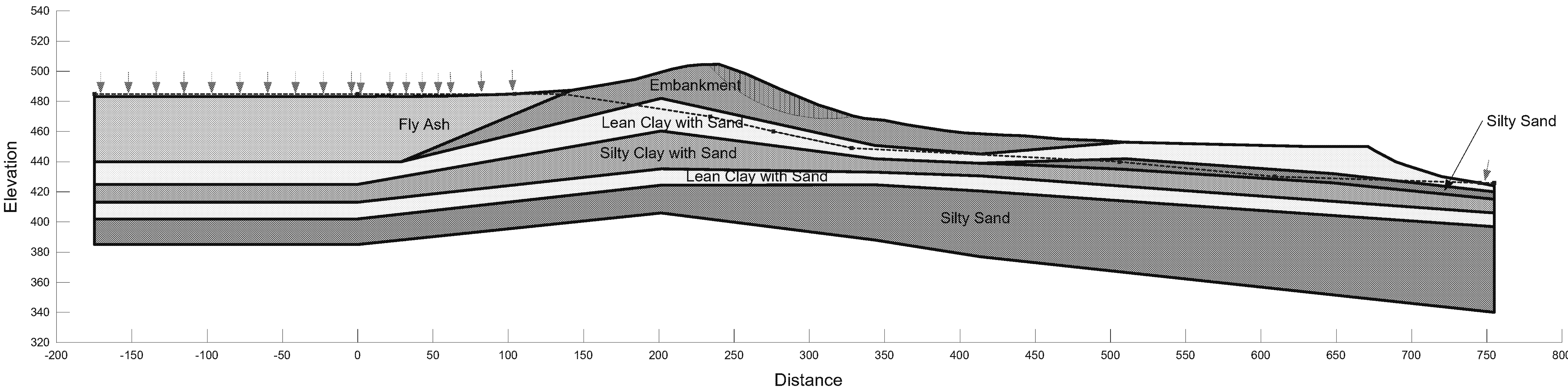
American Electric Power (AEP)
Clifty Creek Landfill Runoff Collection Pond Dam
Madison, Indiana
CCR Mandate

L05_Seismic_Normal Pool, Downstream Crest Loss
Normal Pool Elevation: 485 Feet
Undrained Static Strengths
Incipient Motion in the Downstream Direction
Horizontal Acc: 0.085g
Section E-E'

Note: The results of the analysis shown here are based on available subsurface information, laboratory test results and approximate soil properties. The drawing depicts approximate subsurface conditions based on historical drawings or specific borings at the time of drilling.
No warranties can be made regarding the continuity of subsurface conditions.

Factor of Safety = 1.64

		Drained Strength Parameters		**Undrained Strength Parameters**	
Material	Unit Weight (pcf)	Phi (deg.)	Cohesion (psf)	Phi (deg.)	Cohesion (psf)
Embankment (Seismic Undrained)	129	27.5	198	21	1400
Lean Clay with Sand (Seismic Undrained)	127	28	206	17	1200
Silty Sand (Seismic Undrained)	94	30	0	30	0
Fly Ash (Seismic Undrained)	115	25	0	25	0
Silty Clay with Sand (Seismic Undrained)	118	34	152	20	1000



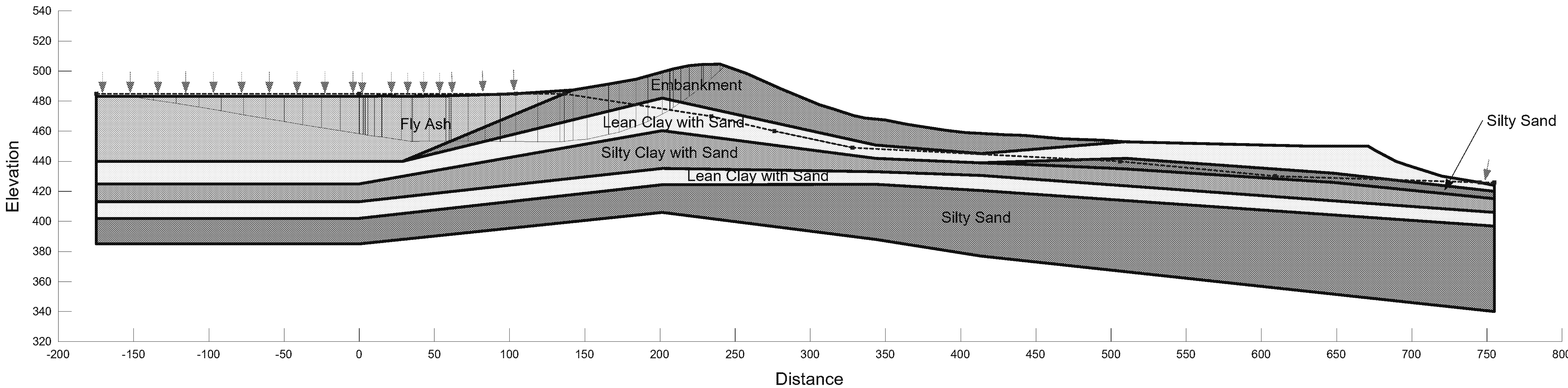
American Electric Power (AEP)
Clifty Creek Landfill Runoff Collection Pond Dam
Madison, Indiana
CCR Mandate

L06_Seismic_Normal Pool, Upstream Crest Loss
Normal Pool Elevation: 485 Feet
Undrained Static Strengths
Incipient Motion in the Upstream Direction
Horizontal Acc: 0.085g
Section E-E'

Note: The results of the analysis shown here are based on available subsurface information, laboratory test results and approximate soil properties. The drawing depicts approximate subsurface conditions based on historical drawings or specific borings at the time of drilling.
No warranties can be made regarding the continuity of subsurface conditions.

Factor of Safety = 2.28

Material	Unit Weight (pcf)	**Drained Strength Parameters** Phi (deg.)	Cohesion (psf)	**Undrained Strength Parameters** Phi (deg.)	Cohesion (psf)
Embankment (Seismic Undrained)	129	27.5	198	21	1400
Lean Clay with Sand (Seismic Undrained)	127	28	206	17	1200
Silty Sand (Seismic Undrained)	94	30	0	30	0
Fly Ash (Seismic Undrained)	115	25	0	25	0
Silty Clay with Sand (Seismic Undrained)	118	34	152	20	1000



SEEP MODELS, 2015

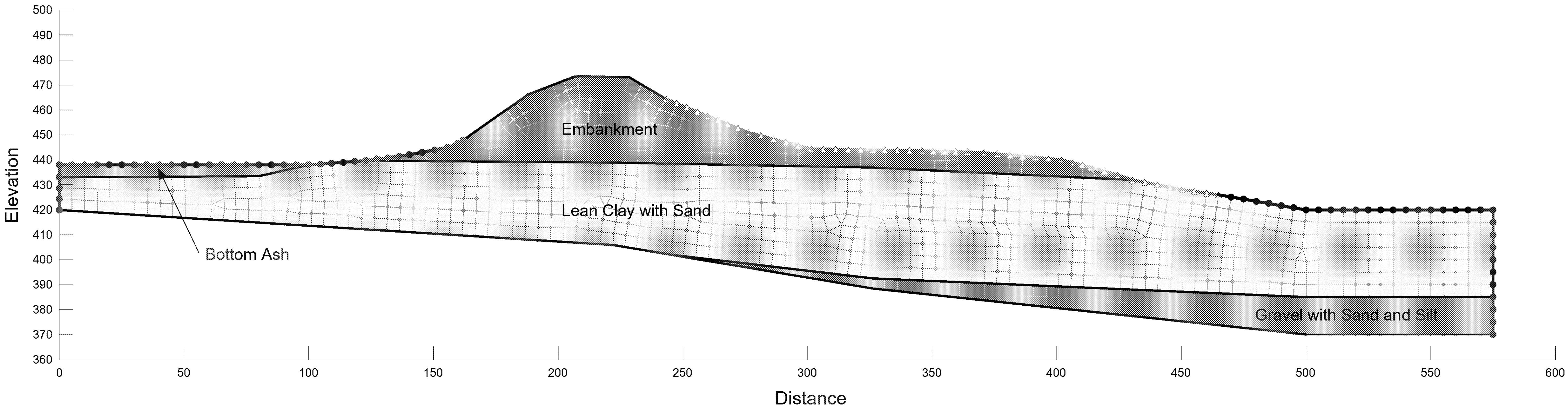
American Electric Power (AEP)
Clifty Creek West Boiler Slag Pond Dam
Madison, Indiana
CCR Mandate

Seepage Analysis
Boundary Condition and Mesh

SEEP Steady State Normal Pool
Normal Pool Elevation: 448 Feet
Drained Static Strengths
Section A-A'

Note: The results of the analysis shown here are based on available subsurface information, laboratory test results and approximate soil properties. The drawing depicts approximate subsurface conditions based on historical drawings or specific borings at the time of drilling.
No warranties can be made regarding the continuity of subsurface conditions.

Material	Kh-sat (ft/sec)	Kratio Kv/Kh	Sat. Water Content ft^3/ft^3	Res. Water Content ft^3/ft^3
Embankment (Drained)	4.72e-008	0.1	0.38	0.109
Lean Clay with Sand (Drained)	2.83e-007	0.1	0.41	0.09
Gravel With Silt and Sand (Drained)	0.00164	0.2	0.23	0.01
Bottom Ash (Drained)	0.0115	1	0.3548	0.027



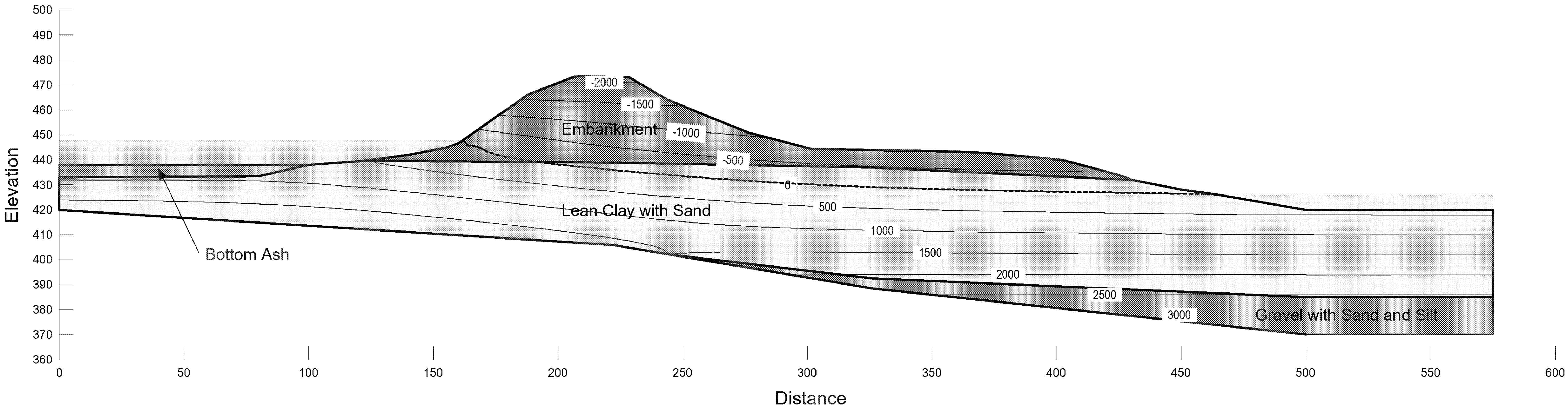
American Electric Power (AEP)
Clifty Creek West Boiler Slag Pond Dam
Madison, Indiana
CCR Mandate

Seepage Analysis
Pore Water Pressure Contour (psf)

SEEP Steady State Normal Pool
Normal Pool Elevation: 448 Feet
Drained Static Strengths
Section A-A'

Note: The results of the analysis shown here are based on available subsurface information, laboratory test results and approximate soil properties. The drawing depicts approximate subsurface conditions based on historical drawings or specific borings at the time of drilling.
No warranties can be made regarding the continuity of subsurface conditions.

Material	Kh-sat (ft/sec)	Kratio Kv/Kh	Sat. Water Content ft^3/ft^3	Res. Water Content ft^3/ft^3
Embankment (Drained)	4.72e-008	0.1	0.38	0.109
Lean Clay with Sand (Drained)	2.83e-007	0.1	0.41	0.09
Gravel With Silt and Sand (Drained)	0.00164	0.2	0.23	0.01
Bottom Ash (Drained)	0.0115	1	0.3548	0.027



American Electric Power (AEP)
Clifty Creek West Boiler Slag Pond Dam
Madison, Indiana
CCR Mandate

Seepage Analysis
Total Head Contour (feet)

SEEP Steady State Normal Pool
Normal Pool Elevation: 448 Feet
Drained Static Strengths
Section A-A'

Note: The results of the analysis shown here are based on available subsurface information, laboratory test results and approximate soil properties. The drawing depicts approximate subsurface conditions based on historical drawings or specific borings at the time of drilling.
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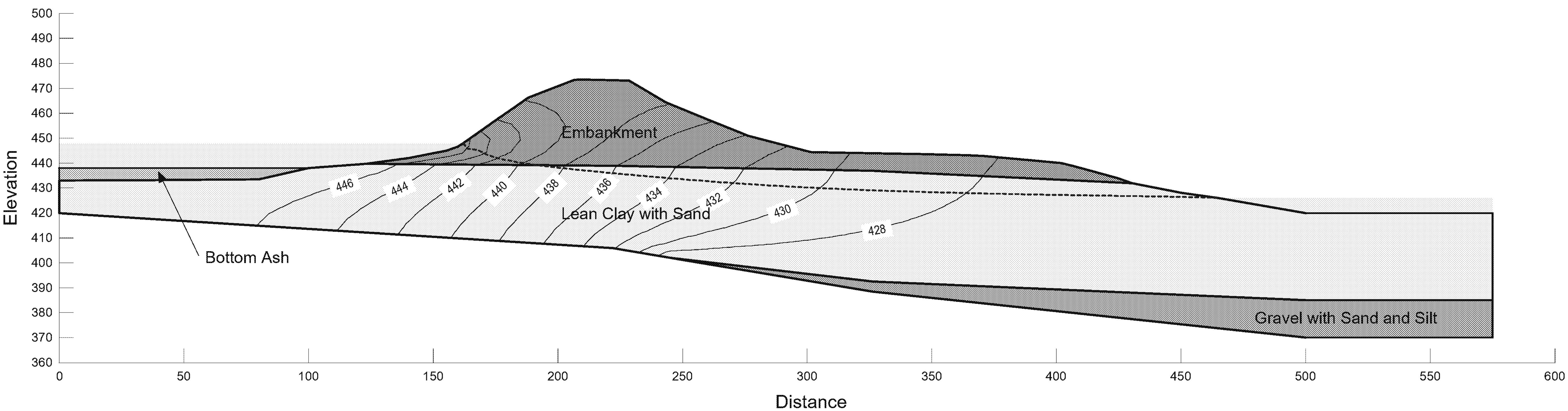

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American Electric Power (AEP)
Clifty Creek West Boiler Slag Pond Dam
Madison, Indiana
CCR Mandate

Seepage Analysis
Boundary Condition and Mesh

SEEP Steady State 50% PMF Pool
50% PMF Pool Elevation: 462.8 Feet
Drained Static Strengths
Section A-A'

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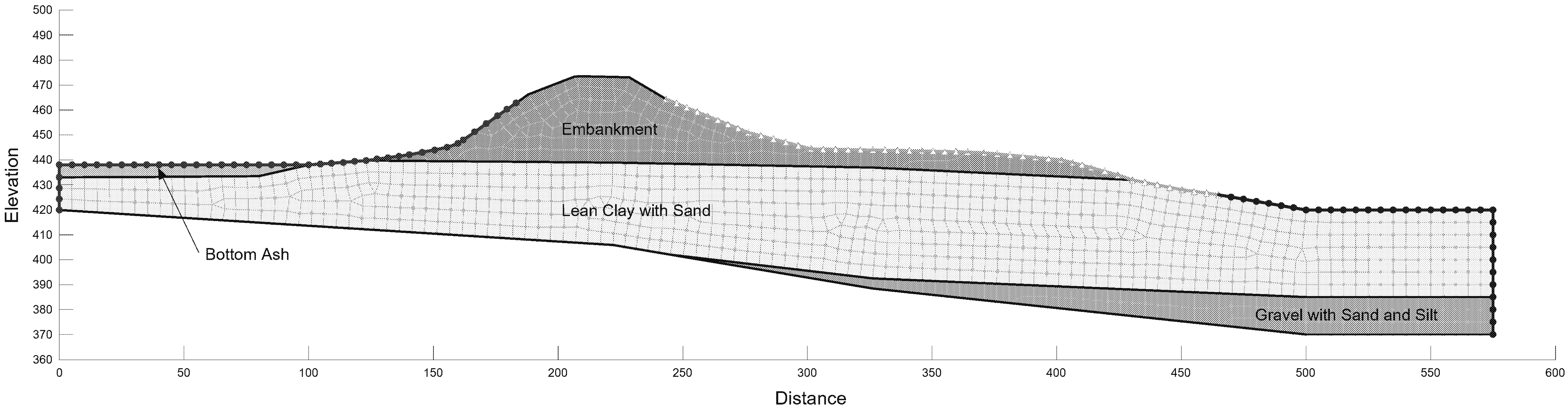

American Electric Power (AEP)
Clifty Creek West Boiler Slag Pond Dam
Madison, Indiana
CCR Mandate

Seepage Analysis
Pore Water Pressure Contour (psf)

SEEP Steady State 50% PMF Pool
50% PMF Pool Elevation: 462.8 Feet
Drained Static Strengths
Section A-A'

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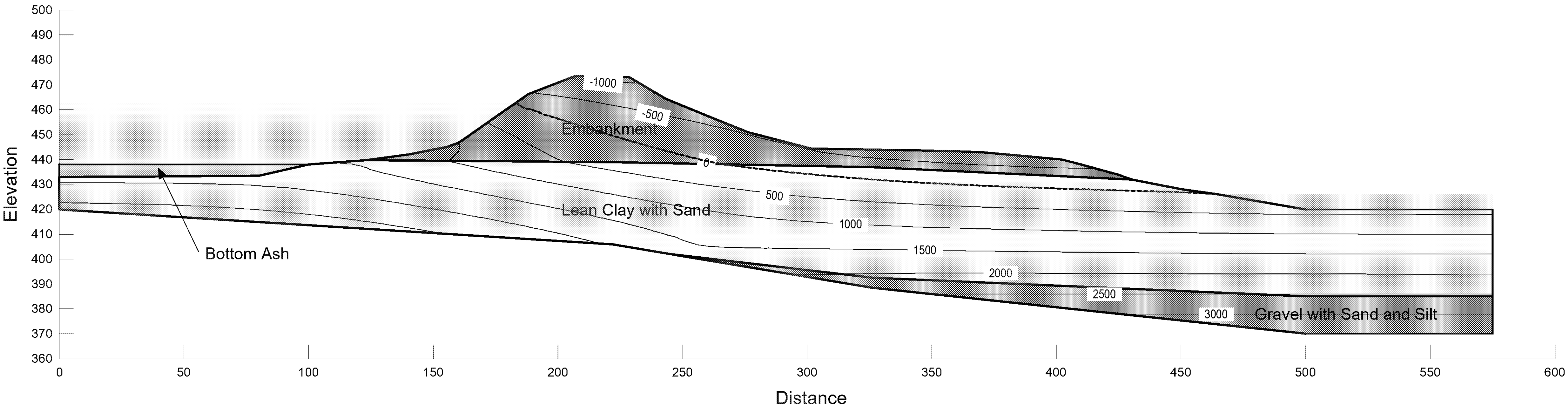

American Electric Power (AEP)
Clifty Creek West Boiler Slag Pond Dam
Madison, Indiana
CCR Mandate

Seepage Analysis
Total Head Contour (feet)

SEEP Steady State 50% PMF Pool
50% PMF Pool Elevation: 462.8 Feet
Drained Static Strengths
Section A-A'

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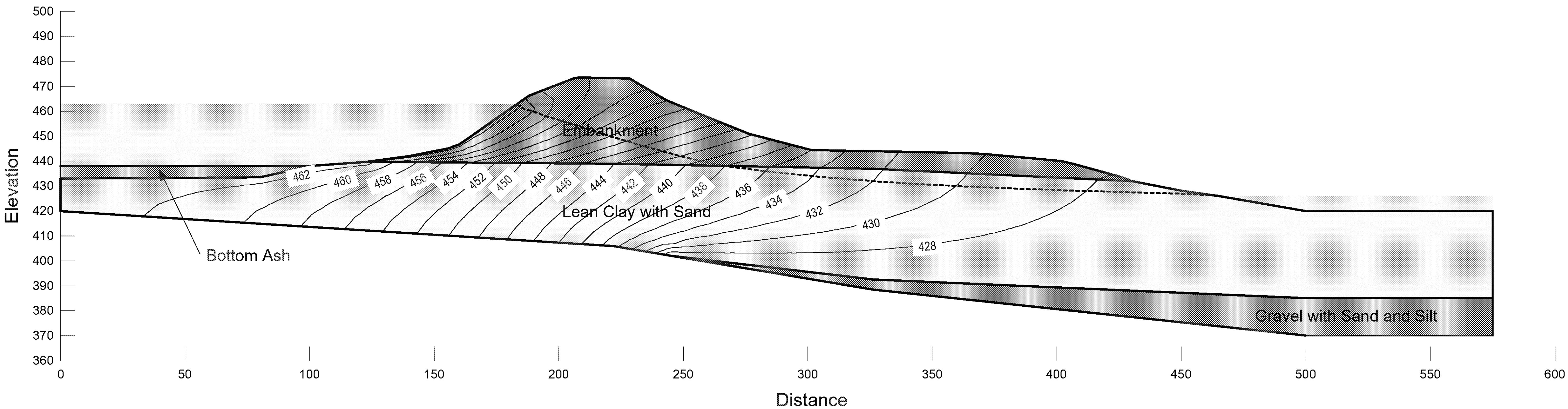

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American Electric Power (AEP)
Clifty Creek West Boiler Slag Pond Dam
Madison, Indiana
CCR Mandate

Seepage Analysis
Boundary Condition and Mesh

SEEP Steady State Normal Pool
Normal Pool Elevation: 448 Feet
Drained Static Strengths
Section B-B'

Note: The results of the analysis shown here are based on available subsurface information, laboratory test results and approximate soil properties. The drawing depicts approximate subsurface conditions based on historical drawings or specific borings at the time of drilling.
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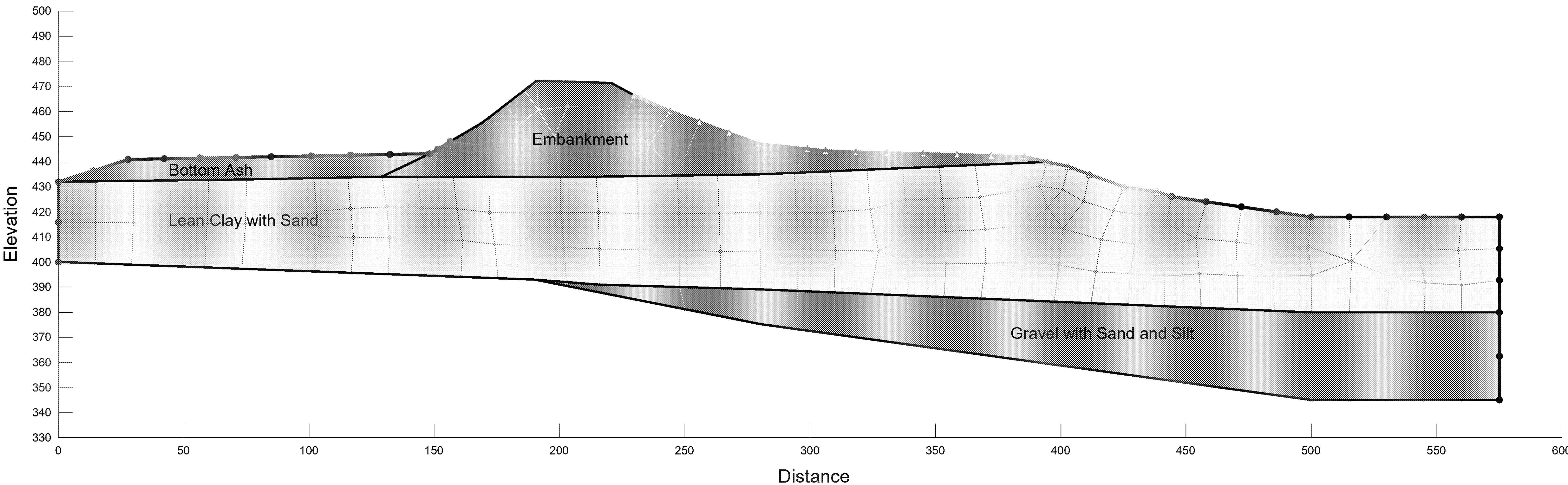

ED_006570_00010329-00697

American Electric Power (AEP)
Clifty Creek West Boiler Slag Pond Dam
Madison, Indiana
CCR Mandate

Seepage Analysis
Pore Water Pressure Contour (psf)

SEEP Steady State Normal Pool
Normal Pool Elevation: 448 Feet
Drained Static Strengths
Section B-B'

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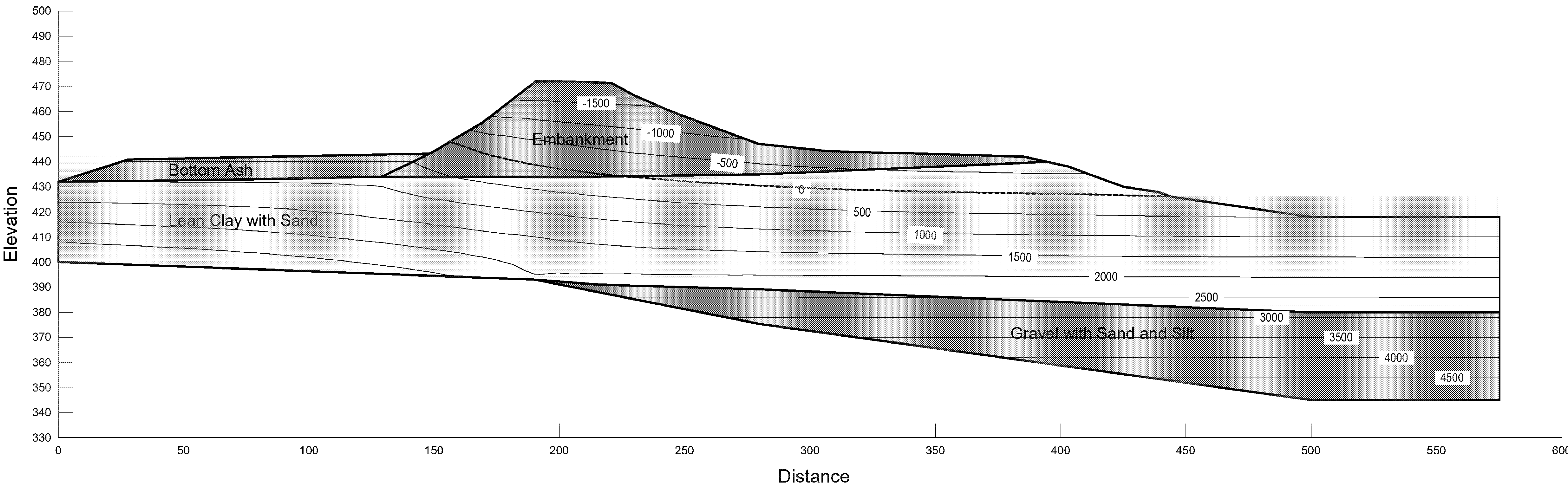

American Electric Power (AEP)
Clifty Creek West Boiler Slag Pond Dam
Madison, Indiana
CCR Mandate

Seepage Analysis
Total Head Contour (feet)

SEEP Steady State Normal Pool
Normal Pool Elevation: 448 Feet
Drained Static Strengths
Section B-B'

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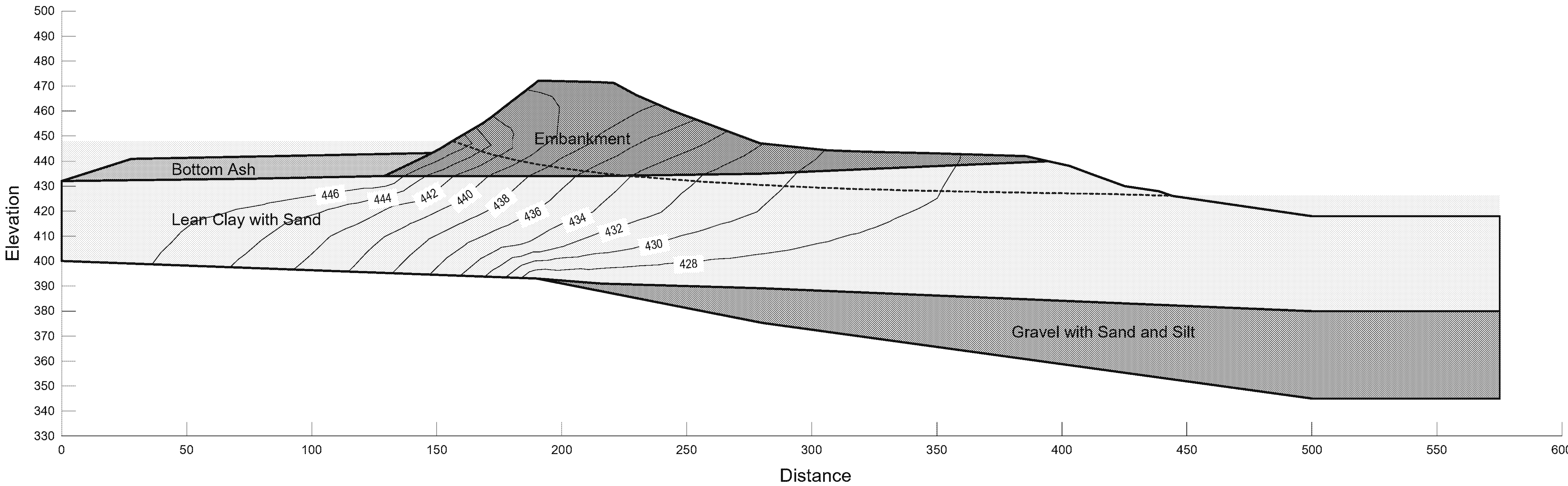

ED_006570_00010329-00699

American Electric Power (AEP)
Clifty Creek West Boiler Slag Pond Dam
Madison, Indiana
CCR Mandate

Seepage Analysis
Boundary Condition and Mesh

SEEP Steady State 50% PMF Pool
50% PMF Pool Elevation: 462.8 Feet
Drained Static Strengths
Section B-B'

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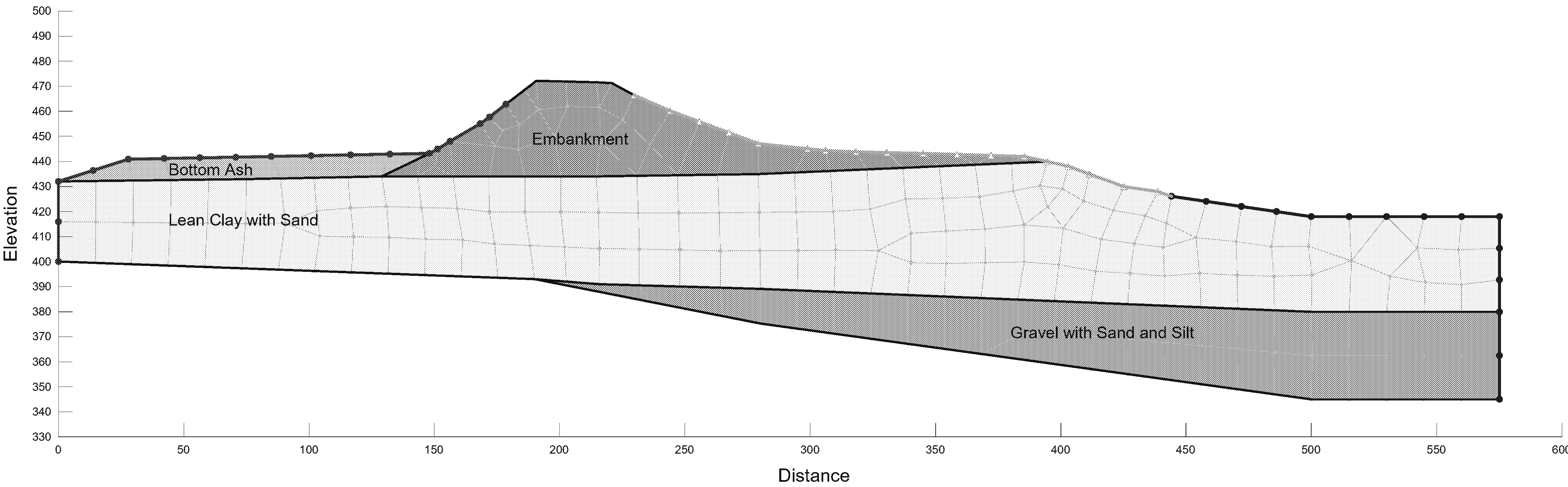

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American Electric Power (AEP)
Clifty Creek West Boiler Slag Pond Dam
Madison, Indiana
CCR Mandate

Seepage Analysis
Pore Water Pressure Contour (psf)

SEEP Steady State 50% PMF Pool
50% PMF Pool Elevation: 462.8 Feet
Drained Static Strengths
Section B-B'

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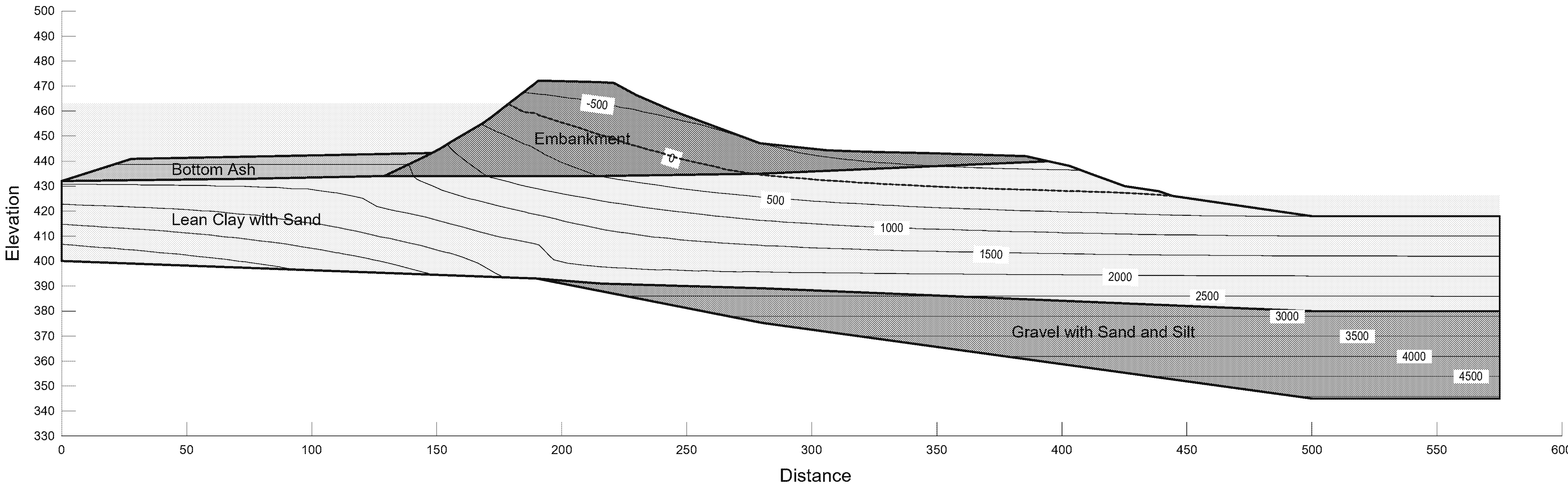

American Electric Power (AEP)
Clifty Creek West Boiler Slag Pond Dam
Madison, Indiana
CCR Mandate

Seepage Analysis
Total Head Contour (feet)

SEEP Steady State 50% PMF Pool
50% PMF Pool Elevation: 462.8 Feet
Drained Static Strengths
Section B-B'

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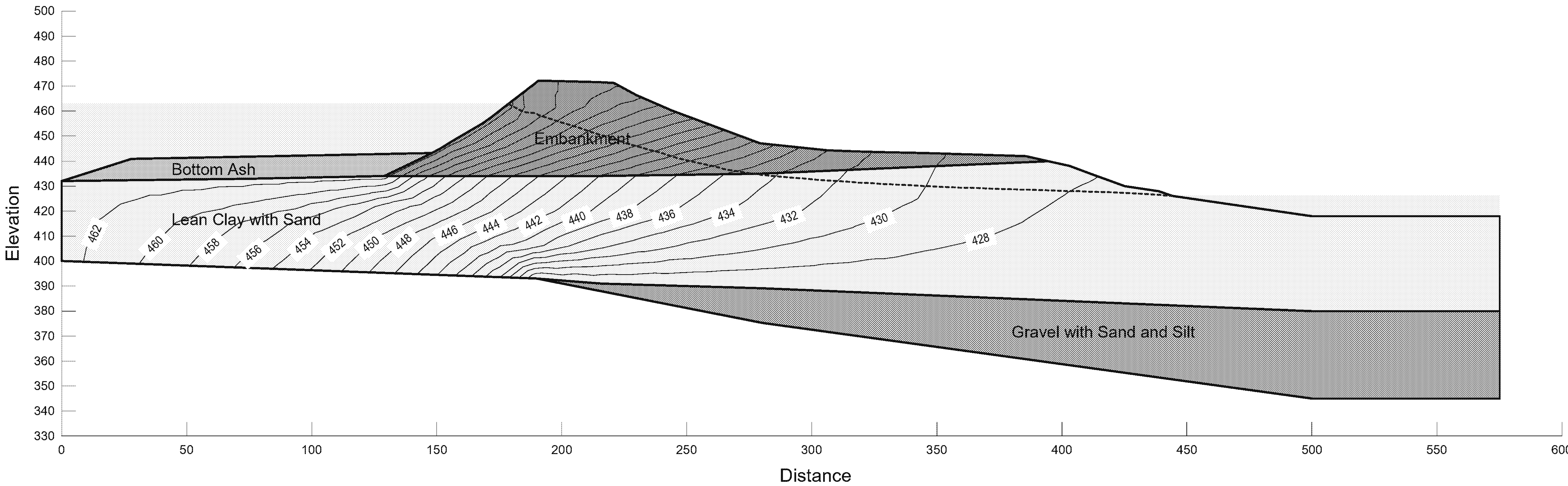

ED_006570_00010329-00702

American Electric Power (AEP)
Clifty Creek West Boiler Slag Pond Dam
Madison, Indiana
CCR Mandate

Seepage Analysis
Boundary Condition and Mesh

SEEP Steady State Normal Pool
Normal Pool Elevation: 448 Feet
Drained Static Strengths
Section C-C'

Note: The results of the analysis shown here are based on available subsurface information, laboratory test results and approximate soil properties. The drawing depicts approximate subsurface conditions based on historical drawings or specific borings at the time of drilling.
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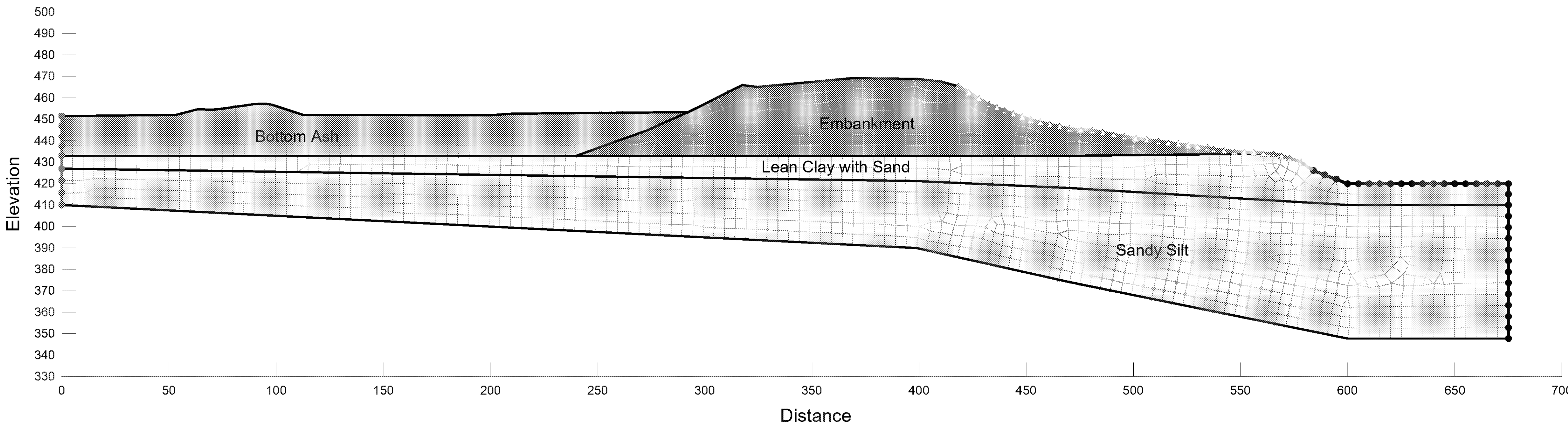
Material	Kh-sat (ft/sec)	Kratio Kv/Kh	Sat. Water Content ft^3/ft^3	Res. Water Content ft^3/ft^3
Embankment (Drained)	4.72e-008	0.1	0.38	0.109
Lean Clay with Sand (Drained)	2.83e-007	0.1	0.41	0.09
Sandy Silt (Drained)	1.64e-005	0.2	0.29	0.01
Bottom Ash (Drained)	0.0115	1	0.3548	0.027



ED_006570_00010329-00703

American Electric Power (AEP)
Clifty Creek West Boiler Slag Pond Dam
Madison, Indiana
CCR Mandate

Seepage Analysis
Pore Water Pressure Contour (psf)

SEEP Steady State Normal Pool
Normal Pool Elevation: 448 Feet
Drained Static Strengths
Section C-C'

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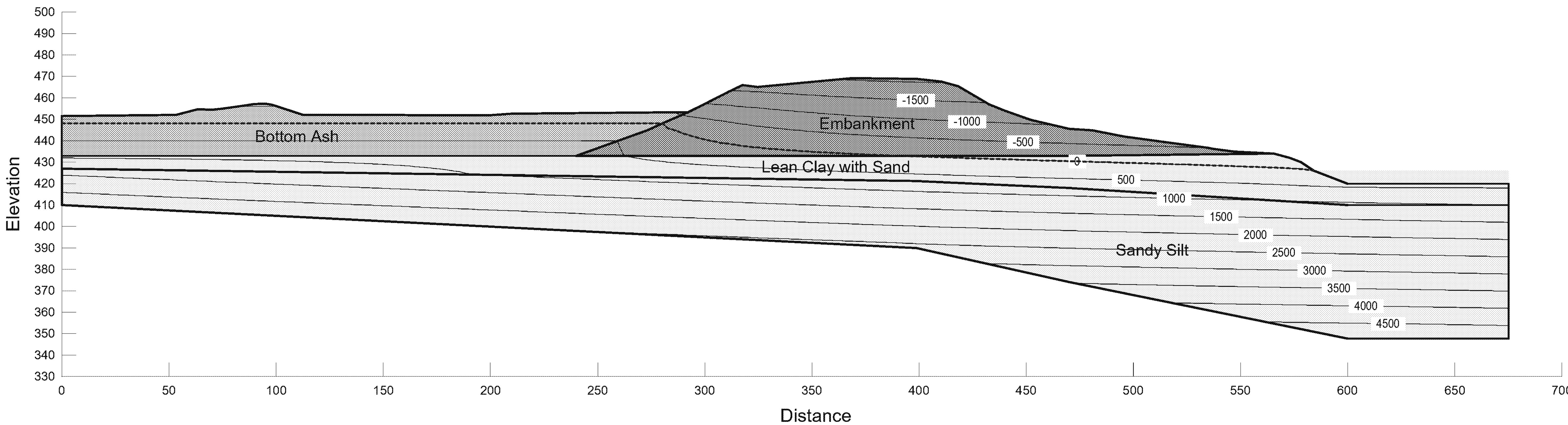

ED_006570_00010329-00704

American Electric Power (AEP)
Clifty Creek West Boiler Slag Pond Dam
Madison, Indiana
CCR Mandate

Seepage Analysis
Total Head Contour (feet)

SEEP Steady State Normal Pool
Normal Pool Elevation: 448 Feet
Drained Static Strengths
Section C-C'

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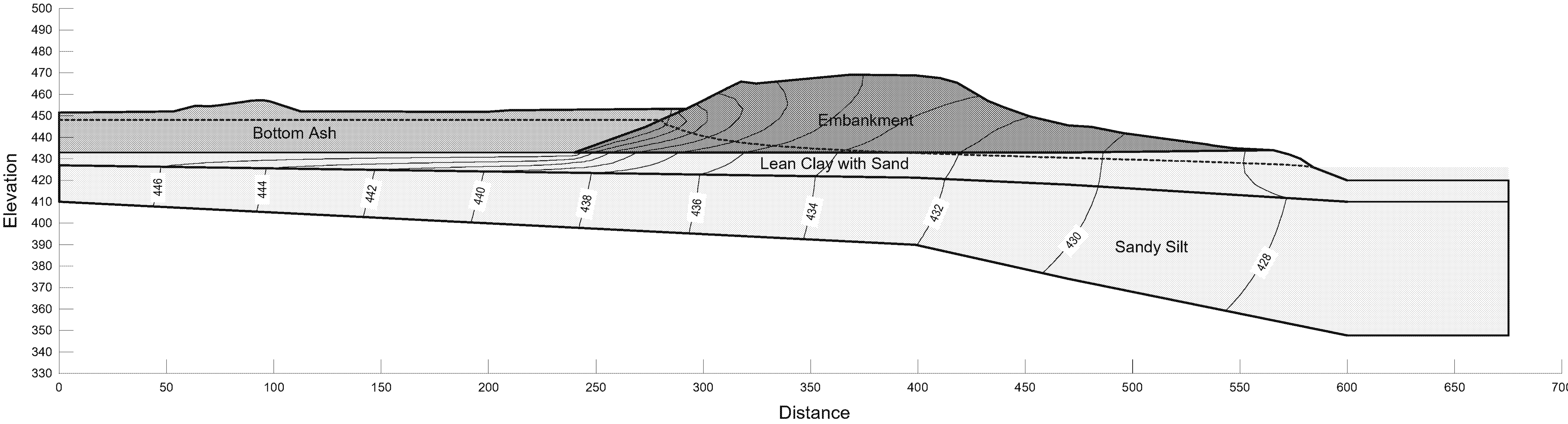

American Electric Power (AEP)
Clifty Creek West Boiler Slag Pond Dam
Madison, Indiana
CCR Mandate

Seepage Analysis
Boundary Condition and Mesh

SEEP Steady State 50% PMF Pool
50% PMF Pool Elevation: 462.8 Feet
Drained Static Strengths
Section C-C'

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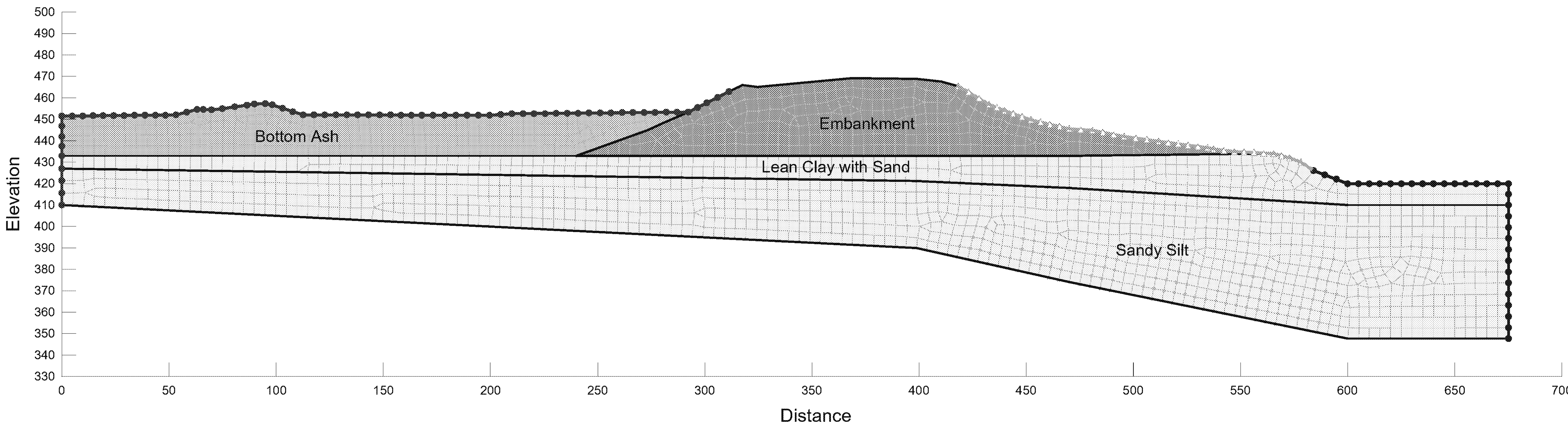

ED_006570_00010329-00706

American Electric Power (AEP)
Clifty Creek West Boiler Slag Pond Dam
Madison, Indiana
CCR Mandate

Seepage Analysis
Pore Water Pressure Contour (psf)

SEEP Steady State 50% PMF Pool
50% PMF Pool Elevation: 462.8 Feet
Drained Static Strengths
Section C-C'

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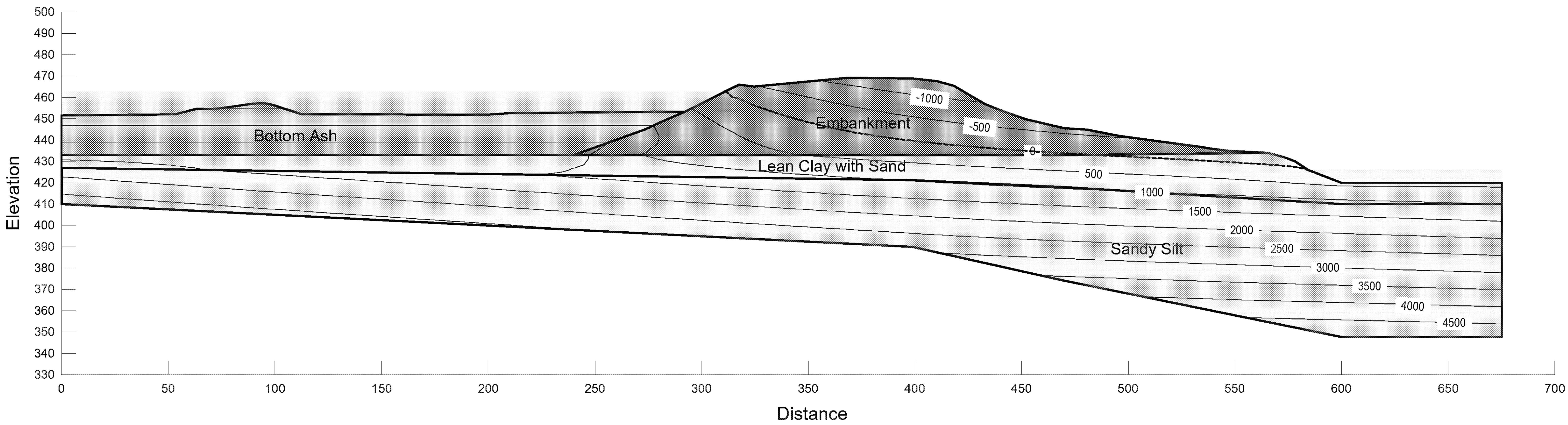

ED_006570_00010329-00707

American Electric Power (AEP)
Clifty Creek West Boiler Slag Pond Dam
Madison, Indiana
CCR Mandate

Seepage Analysis
Total Head Contour (feet)

SEEP Steady State 50% PMF Pool
50% PMF Pool Elevation: 462.8 Feet
Drained Static Strengths
Section C-C'

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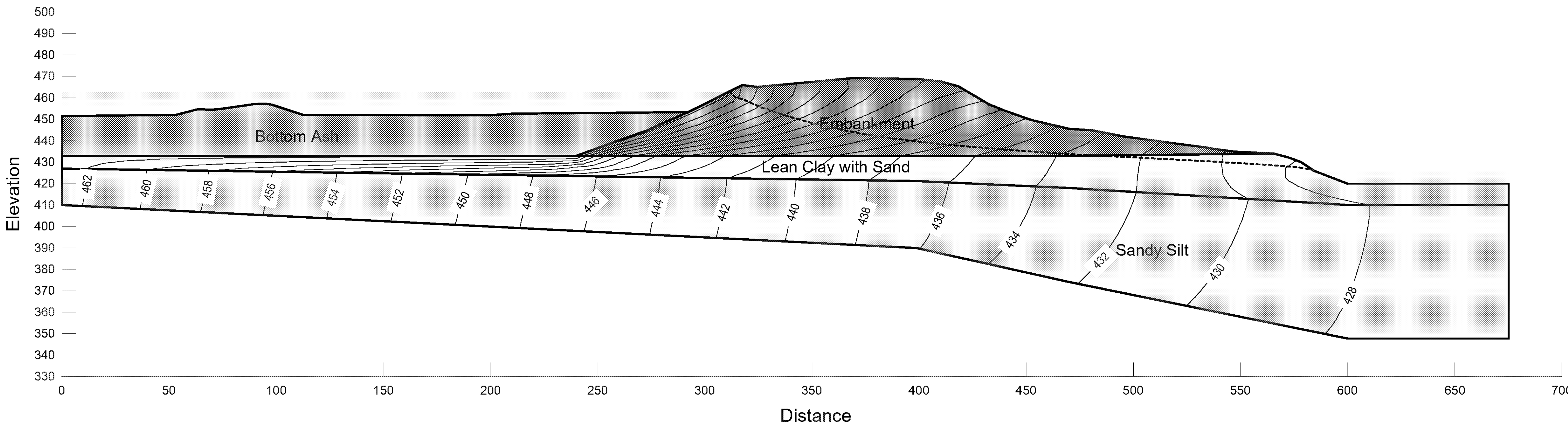


APPENDIX J

PARAMETER DERIVATIONS

BOILER SLAG POND DAM: 2010 PARAMETER DERIVATIONS

WEST BOTTOM ASH DAM GEOTECHNICAL ANALYSIS

CALCULATION SHEET

I. Subsurface Exploration Program Development:

Three cross sections across the dam were analyzed with two borings on each section: On the crest and at the toe.

II. Laboratory Testing Program:

The program was developed based on visual classifications done in the field during subsurface exploration.

- USCS Soil Classification Tests
- CU Triaxial Compression Tests
- Permeability Tests.
- Moisture Density tests.

III. Geotechnical Analysis:

A soil tests summary was developed to select soil parameters to use in the geotechnical analysis. Engineering properties that were not directly tested were determined using typical soil parameter values from NAVFAC DM7-02 Foundations and Earth Structures (Table 1 on Page 39) and the Center For Geotechnical Practice and Research, Performance and Use of the Standard Penetration Test in Geotechnical Engineering Practice report (Figures 34 and 35 on pages 71 and 72 respectively). The two tables are attached at the end of the parameter derivation notes.

Permeability k values that were not tested in the laboratory were selected from typical values provided in the table below and those provided in NAVFAC DM7.02, table 1: Typical Properties of Compacted soils

Soil Type	k_v(cm/s)
Coarse Sand	$>10^{-1}$
Fine Sand	10^{-1} to 10^{-3}
Silty Sand	10^{-3} to 10^{-5}
Silt	10^{-5} to 10^{-7}
Clay	$<10^{-7}$

Soils from the West Bottom Ash Dam were classified into 5 main soil layers.

The following table shows how pertinent parameters were selected and which sections they were applied to.

Soil name	USCS class	Classification Samples	Shear Strength Parameters	Permeability Parameters	Section
Embankment fill	CL	B-1,(10-11.5)(12.5-14)	Triaxial Test No 1	Test ID 7A	A / B / C
Lean Clay with Sand	CL	B-2,(32.5-34)(35-36.5)	Triaxial Test No 2	Average of test ID 48A & 82A	A / B / C
Gravel With Silt and Sand	GW-GM	B-4,(57.5-59)(60-61.5)	Typical values *	Typical values *	A / B
Sand Silt/ Silt with Sand	ML	B-5,(55-56.5)(57.5-59)	Typical values *	Typical values *	C
Bottom Ash		Averaged results from WBAP trench testing.**	Typical values *	Averaged results from WBAP trench testing.	A / B / C

* Typical values as determined from referenced tables.
** Table attached at end of appendix

Soil name	Unit Weight	C	ϕ	K_v (cm/sec)	K_h/K_v	g	e
Embankment fill	130	165	33	1.44 E-07	10	2.72 (ST sample)	0.609 (ST sample)
Lean Clay with Sand	119	160	24	8.62 E-07	10	2.69 (ST sample)	0.700 (ST sample
Gravel With Silt and Sand	130	0	35	1.00 E-02	5	2.70	0.300
Sand Silt/ Silt with Sand	130	0	30	1.00 E-04	5	2.70	0.400
Bottom Ash	115	0	28	3.5E-01	1		

1. SEEPAGE ANALYSIS.

Geoslope Seep W analysis was used to analyze the model for Seepage. Field piezometer readings were compared to the model's results. The model was calibrated to approximate field water elevations.

Residual and saturated water contents and coefficients of volume compressibility were assumed for all soil layers based on previous experiences and soils' normal values.

Water elevations used were:

- Existing (normal) water elevation in the pond: 442 feet.
- Maximum possible impounded water elevation (spillway highest grate): 457.7 feet
- Ohio River water elevation 426 feet.

Seepage analysis results were used in the slope stability analysis to model pore water pressures.

2. STABILITY ANALYSIS.

Geoslope Slope W was used for the slope stability analysis.

The Spencer Analysis Method was used.

Slip circle method and siding wedge method were modeled by the circular failure plane and the block specified; the circular failure plane produced lower Factors of Safety.

The peak ground acceleration used for the seismic analysis was obtained from US Geological Survey website. The PGA used is 0.08g (USGS indicates 0.07677g). The method selected to do the seismic analysis was the pseudostatic analysis per the project scope.

Loading conditions:

Static Slope Stability Loading Conditions:

- Steady state Seepage normal pool (upstream and downstream slopes): 442 feet
- Steady state seepage maximum pool (upstream and downstream slopes): 457.7 feet
- Rapid drawdown: normal pool steady-state seepage conditions with empty pond and dredged conditions above elevation 433 feet (upstream slope)
- PMF event (upstream and downstream slopes). The flood water was considered as a surcharge and the maximum pool steady state pore pressure line was used, as the water elevation selected for the PMF event is the result of a flood occurring while the dam had the maximum water pool. PMF event water elevation in the pond is: 468.4 feet.

Seismic Slope Stability Loading Conditions:

- Steady state seepage normal pool (upstream and downstream slopes): 442 feet
- Steady state seepage maximum pool (upstream and downstream slopes): 457.7 feet

3. <u>LIQUEFACTION ANALYSIS</u>.

<u>Research and methodology:</u>

- Earthquake intensity: USGS website used to determine the Peak Ground Acceleration and earthquake intensity for an earthquake event of a mean return period of 2,475 years. PGA = 0.07677g, the value used in the analysis is 0.08g and M_L = 7.7.

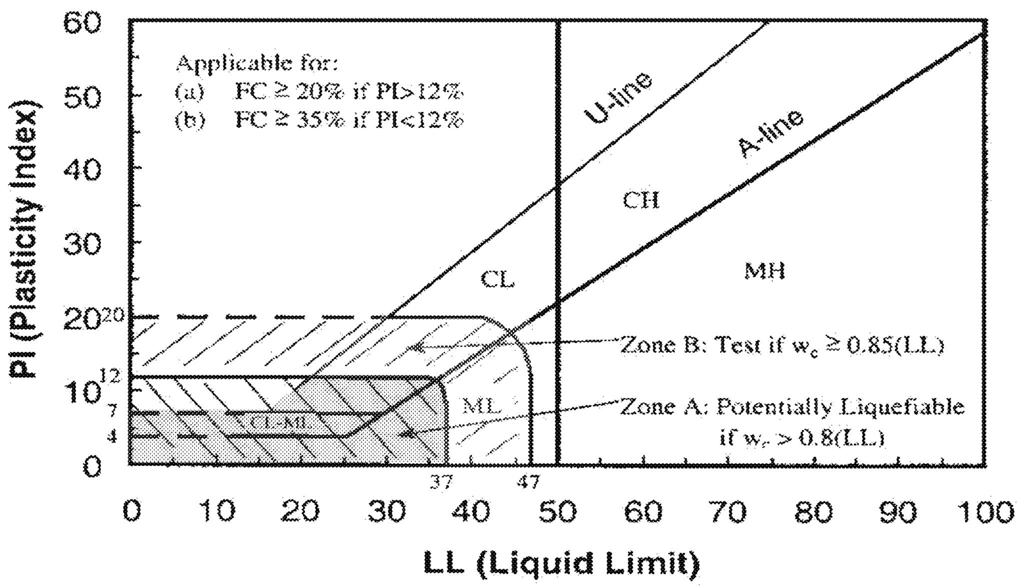
- Groundwater table: Normal (current) steady state water elevations were considered as the groundwater elevation. Unsaturated soil located above the groundwater table will not liquefy.

- Soil Type:

  The dam soil materials, being constructed of engineered fill located above the groundwater table, are not considered liquefiable.

  Cohesionless materials are considered liquefiable. The majority of cohesive soils will not liquefy. Cohesive soils susceptible to liquefaction should fall in either zone A or zone B of the following chart.

Screening Criteria for Liquefiable Fine-Grained Soils (Seed et al. 2003)



- Soil relative density (Dr): Soils in a loose relative density state are susceptible to liquefaction. Soils with an SPT-N value of 30 or higher were considered not liquefiable.

Liquefaction Assessment

To assess liquefaction potential for the WBAD, the boring logs from the geotechnical borings and laboratory test data from Shelby tubes and SPT samples were used. The boring logs include the SPT blow counts and soil lithologic descriptions with depth.

Soil characteristics (grain size, plasticity, unit weight, moisture content) from SPT and Shelby tube samples obtained from the geotechnical borings were used in the liquefaction assessment.

Method Used: Simplified Method based on using correlations to blow counts from Standard Penetration Tests (SPTs) as set forth in Youd et al (2001) and discussed in NRC (1985).

The Simplified Method requires estimating the Cyclic Stress Ratio (CSR) and Cyclic Resistance Ratio (CRR) of the soil. The CRR can be estimated using information from SPT tests, corrected to account for various effects. To use the Simplified Method, the SPT N value is normalized to an overburden pressure of approximately 100 kiloPascals (kPa) and a hammer energy ratio of 60% and procedural effects (rod length, sample configuration and borehole diameter).

The $(N_1)_{60}$ may also be corrected for the percent of fines using the relationship:

$$(N_1)_{60cs} = \alpha + \beta (N_1)_{60}$$

It is important to note that the fines correction is an approximation and is only valid for nonplastic fines and with a fines content between 0 and 35%. This correction factor, although widely used, is considered as a rough approximation only.

Once the corrected value for $(N_1)_{60}$ is found, the CRR is calculated as:

$$CRR_{7.5} = \frac{1}{34-(N_1)_{60}} + \frac{(N_1)_{60}}{135} + \frac{50}{[10*(N_1)_{60}+45]^2} - \frac{1}{200}$$

Note that the value calculated is the CRR normalized to a 7.5 magnitude earthquake, hence the $CRR_{7.5}$ notation. When evaluating the liquefaction potential of soil, the $CRR_{7.5}$ must be corrected to the magnitude earthquake of interest.

The CSR is independent of soil properties and may be approximated using the equation:

$$CSR = 0.65(\frac{a_{max}}{g})(\frac{\sigma_v}{\sigma_v'})r_d$$

where:

a_{max} is the maximum ground acceleration.
g is the acceleration of gravity.
σ_v is the total vertical stress.
σ_v' is the effective vertical stress.

r_d is a stress reduction coefficient.

Liquefaction potential for a soil unit is evaluated by dividing $CRR_{7.5}$ by CSR and then correcting to the magnitude earthquake of interest, as:

$$FS = \frac{CRR_{7.5}}{CSR} * MSF$$

Field experience has shown that the Simplified Method is somewhat conservative; so many designers consider FS values close to unity as an indication of no liquefaction.

B-1

Elevation	Depth	Soil class	N	Remarks
470.2	3.25	CL	11	Not liquefiable. Embankment and located above ground water
467.7	5.75	CL	10	
462.7	10.75	CL	10	
460.2	13.25	CL	7	
455.2	18.25	CL	15	
452.7	20.75	CL	15	
450.2	23.25	CL	14	
447.7	25.75	CL	8	
445.2	28.25	CL	12	
442.7	30.75	CL	11	
440.2	33.25	CL	9	
437.7	35.75	CL	10	
435.2	38.25	CL	6	
432.7	40.75	CL	5	
427.7	45.75	CL	2	Evaluated for liquefaction
425.2	48.25	CL	3	
422.7	50.75	CL	4	
420.2	53.25	CL	2	
417.7	55.75	CL	4	
415.2	58.25	CL	4	
412.7	60.75	CL	5	
410.2	63.25	CL	6	
407.7	65.75	CL	7	

B-2

Elevation	Depth	Soil class	N-field	Remarks
440.8	3.25	CL	19	Not liquefiable as layer is above ground water
438.3	5.75	CL	7	
435.8	8.25	CL	7	
430.8	13.25	CL	5	
428.3	15.75	CL	4	
425.8	18.25	CL	2	Evaluated for liquefaction
423.3	20.75	CL	4	

418.3	25.75	CL	4	
415.8	28.25	CL	9	
413.3	30.75	CL	6	
410.8	33.25	CL	6	
408.3	35.75	CL	5	
405.8	38.25	CL	4	
403.3	40.75	CL	6	
398.3	45.75	CL	2	
393.3	50.75	GW - GM	50	Not liquefiable

B-3

Elevation	Depth	Soil class	N-field	Remarks
468.4	3.25	CL	11	Not liquefiable. Embankment and located above ground water
465.9	5.75	CL	8	
463.4	8.25	CL	10	
458.4	13.25	CL	9	
455.9	15.75	CL	10	
453.4	18.25	CL	12	
448.4	23.25	CL	12	
445.9	25.75	CL	9	
443.4	28.25	CL	15	
440.9	30.75	CL	10	
438.4	33.25	CL	17	
435.9	35.75	CL	16	
433.4	38.25	CL	18	
430.9	40.75	CL	4	Evaluated for liquefaction
428.4	43.25	CL	4	
425.9	45.75	CL	6	
420.9	50.75	CL	4	
418.4	53.25	CL	2	
415.9	55.75	CL	5	
413.4	58.25	CL	2	
410.9	60.75	CL	8	
408.4	63.25	CL	6	
405.9	65.75	CL	7	
403.4	68.25	CL	9	
400.9	70.75	CL	8	

B-4

Elevation	Depth	Soil class	N-field	Remarks
443.5	3.25	CL	16	Not liquefiable as located above ground water
441.0	5.75	CL	15	
436.0	10.75	CL	11	
433.5	13.25	CL	7	
431.0	15.75	CL	5	

426.0	20.75	CL	4	Evaluated for liquefaction
424.5	22.25	CL	5	
421.0	25.75	CL	6	
418.5	28.25	CL	5	
416.0	30.75	CL	3	
413.5	33.25	CL	4	
411.0	35.75	CL	9	
406.0	40.75	CL	4	
403.5	43.25	CL	5	
401.0	45.75	CL	8	
398.5	48.25	CL	6	
396.0	50.75	CL	7	
393.5	53.25	CL	5	
391.0	55.75	CL	7	
388.5	58.25	GW - GM	39	Not liquefiable as layer is very dense
386.0	60.75	GW - GM	46	
381.5	65.25	GW - GM	50	
376.0	70.75	GW - GM	52	

B-5

Elevation	Depth	Soil class	N-field	Remarks
465.5	3.25	CL	19	Not liquefiable. Embankment and located above ground water
463.0	5.75	CL	9	
458.0	10.75	CL	15	
455.5	13.25	CL	10	
453.0	15.75	CL	7	
450.5	18.25	CL	16	
448.0	20.75	CL	7	
443.0	25.75	CL	8	
440.5	28.25	CL	7	
438.0	30.75	CL	12	
435.5	33.25	CL	8	
433.0	35.75	CL	16	
430.5	38.25	CL	6	
428.0	40.75	CL	3	Evaluated for liquefaction
423.0	45.75	CL	4	
420.5	48.25	ML	4	Evaluated for liquefaction
418.0	50.75	ML	6	
415.5	53.25	ML	2	
413.0	55.75	ML	4	
410.5	58.25	ML	5	
408.0	60.75	ML	7	
405.5	63.25	ML	9	
403.0	65.75	ML	11	
400.5	68.25	ML	9	
398.0	70.75	ML	13	

B-6

Elevation	Depth	Soil class	N-field	Remarks
442.3	3.25	CL	8	Not liquefiable as layer is above ground water
439.8	5.75	CL	10	
434.8	10.75	CL	18	
432.3	13.25	CL	4	
429.8	15.75	CL	3	
424.8	20.75	CL	1	Evaluated for liquefaction
422.3	23.25	CL	2	
419.8	25.75	CL	4	
417.3	28.25	ML	5	Evaluated for liquefaction
414.8	30.75	ML	3	
412.3	33.25	ML	3	
409.8	35.75	ML	1	
407.3	38.25	ML	1	
402.3	43.25	ML	2	
399.8	45.75	ML	1	
397.3	48.25	ML	1	
394.8	50.75	ML	5	
392.3	53.25	ML	11	
389.8	55.75	ML	4	
387.3	58.25	ML	9	
384.8	60.75	ML	11	
379.8	65.75	ML	9	
374.8	70.75	ML	10	

TABLE 1
Typical Properties of Compacted Soils

Group Symbol	Soil Type	Range of Maximum Dry Unit Weight, pcf	Range of Optimum Moisture, Percent	Typical Value of Compression (Percent of Original Height): At 1.4 tsf (20 psi)	Typical Value of Compression (Percent of Original Height): At 3.6 tsf (50 psi)	Typical Strength Characteristics: Cohesion (as compacted) psf	Typical Strength Characteristics: Cohesion (saturated) psf	Typical Strength Characteristics: ϕ (Effective Stress Envelope Degrees)	Typical Strength Characteristics: Tan ϕ	Typical Coefficient of Permeability ft./min.	Range of CBR Values	Range of Subgrade Modulus k lbs/cu in.
GW	Well graded clean gravels, gravel-sand mixtures.	125 - 135	11 - 8	0.3	0.6	0	0	>38	>0.79	5×10^{-2}	40 - 80	300 - 500
GP	Poorly graded clean gravels, gravel-sand mix	115 - 125	14 - 11	0.4	0.9	0	0	>37	>0.74	10^{-1}	30 - 60	250 - 400
GM	Silty gravels, poorly graded gravel-sand-silt.	120 - 135	12 - 8	0.5	1.1	.....	.....	>34	>0.67	$>10^{-6}$	20 - 60	100 - 400
GC	Clayey gravels, poorly graded gravel-sand-clay.	115 - 130	14 - 9	0.7	1.6	.....	.....	>31	>0.60	$>10^{-7}$	20 - 40	100 - 300
SW	Well graded clean sands, gravelly sands.	110 - 130	16 - 9	0.6	1.2	0	0	38	0.79	$>10^{-3}$	20 - 40	200 - 300
SP	Poorly graded clean sands, sand-gravel mix.	100 - 120	21 - 12	0.8	1.4	0	0	37	0.74	$>10^{-3}$	10 - 40	200 - 300
SM	Silty sands, poorly graded sand-silt mix.	110 - 125	16 - 11	0.8	1.6	1050	420	34	0.67	$5 \times >10^{-5}$	10 - 40	100 - 300
SM-SC	Sand-silt clay mix with slightly plastic fines.	110 - 130	15 - 11	0.8	1.4	1050	300	33	0.66	$2 \times >10^{-6}$	5 - 30	100 - 300
SC	Clayey sands, poorly graded sand-clay-mix.	105 - 125	19 - 11	1.1	2.2	1550	230	31	0.60	$5 \times >10^{-7}$	5 - 20	100 - 300
ML	Inorganic silts and clayey silts.	95 - 120	24 - 12	0.9	1.7	1400	190	32	0.62	$>10^{-5}$	15 or less	100 - 200
ML-CL	Mixture of inorganic silt and clay.	100 - 120	22 - 12	1.0	2.2	1350	460	32	0.62	$5 \times >10^{-7}$	.....	
CL	Inorganic clays of low to medium plasticity.	95 - 120	24 - 12	1.3	2.5	1800	270	28	0.54	$>10^{-7}$	15 or less	50 - 200
OL	Organic silts and silt-clays, low plasticity.	80 - 100	33 - 21	.....	.....	.....	.....	.....	.....	.....	5 or less	50 - 100
MH	Inorganic clayey silts, elastic silts.	70 - 95	40 - 24	2.0	3.8	1500	420	25	0.47	$5 \times >10^{-7}$	10 or less	50 - 100
CH	Inorganic clays of high plasticity	75 - 105	36 - 19	2.6	3.9	2150	230	19	0.35	$>10^{-7}$	15 or less	50 - 150
OH	Organic clays and silty clays	65 - 100	45 - 21	.....	.....	.....	.....	.....	.....	.....	5 or less	25 - 100

Notes:

1. All properties are for condition of "Standard Proctor" maximum density, except values of k and CBR which are for "modified Proctor" maximum density.
2. Typical strength characteristics are for effective strength envelopes and are obtained from USBR data.
3. Compression values are for vertical loading with complete lateral confinement.
4. (>) indicates that typical property is greater than the value shown.
(..) indicates insufficient data available for an estimate.

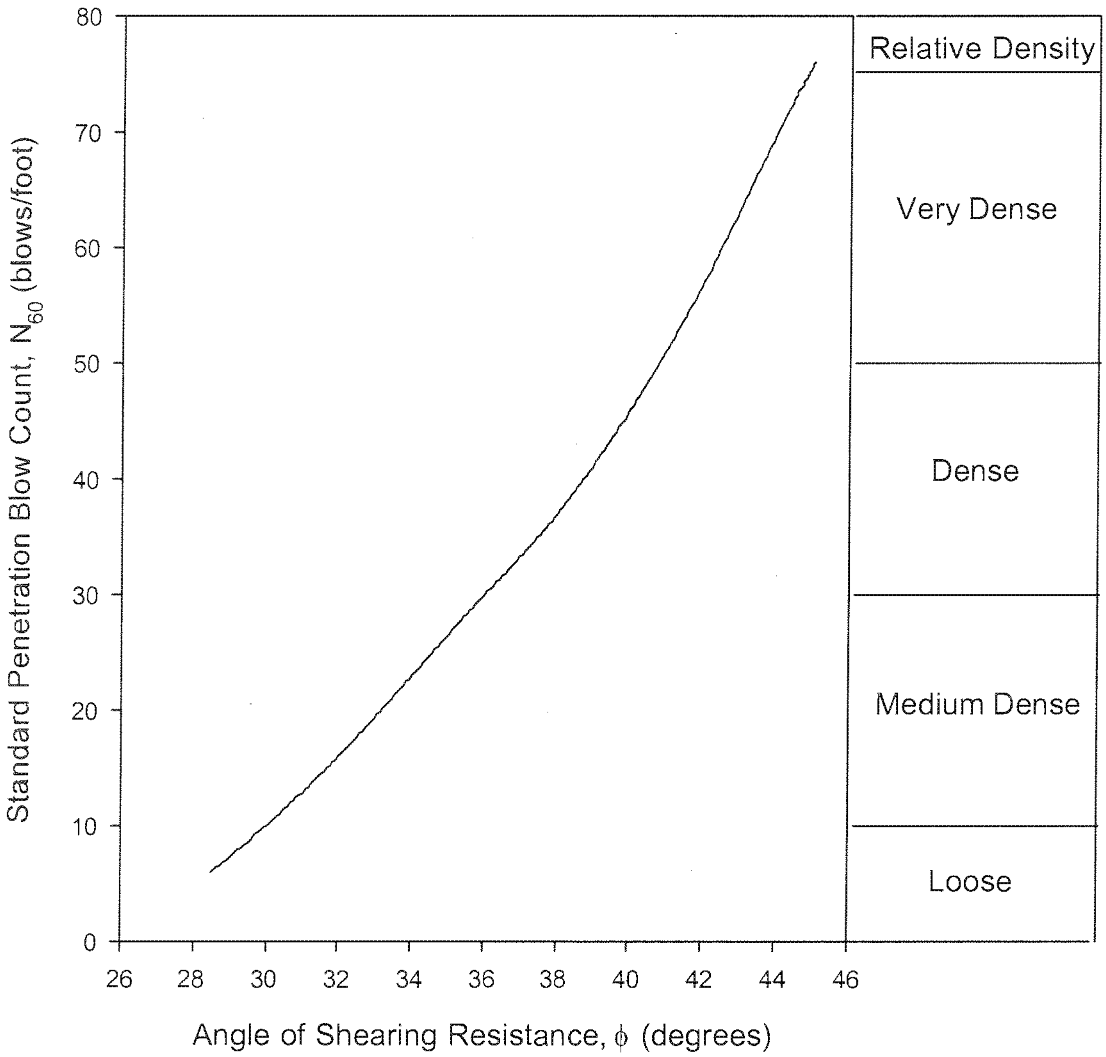


Figure 35. Estimation of the angle of shearing resistance of granular soils from standard penetration test results (Originally from Peck et al., 1974, modified by Carter and Bentley, 1991).

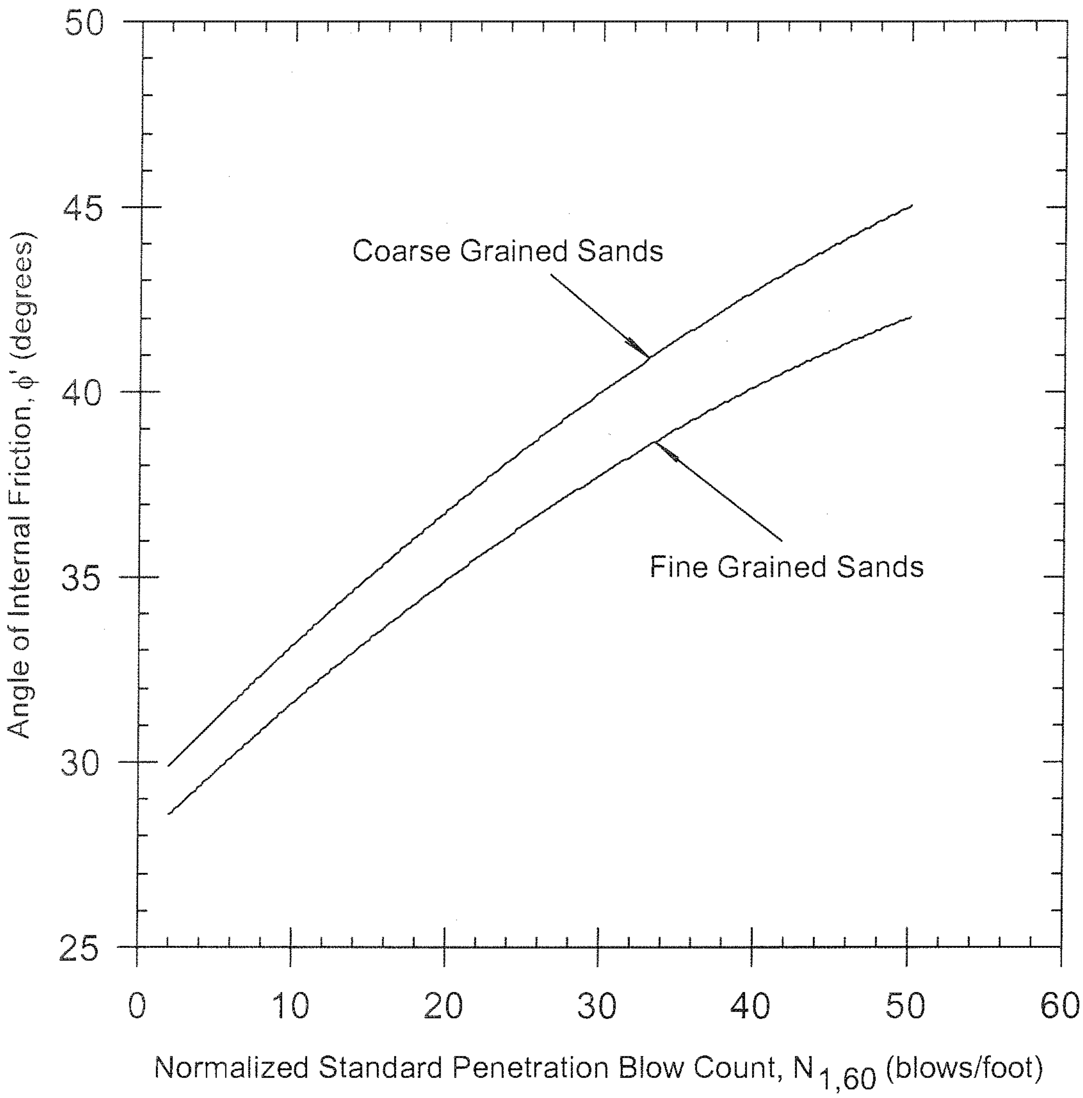


Figure 34. Empirical correlation between friction angle of sands and normalized standard penetration blow count (after Terzaghi et al., 1996)

WBAP Trench Testing (Bottom Ash Testing)

ASTM D 422, C 136

Sample	Classification	ω (%)	D_{10} (mm)	D_{30} (mm)	D_{60} (mm)	Cu	Cc	3" 75	1 1/2" 37.5	1" 25.0	3/4" 19.0	Sieve Size (% Passing) 3/8" 9.5	No. 4 4.75	No. 10 2	No. 40 0.425	No. 200 0.075	Pan 0.01	% Gravel	% Sand	% Fines	K(cm/s) 20o C	Fines Classification
1	Well Graded Sand (SW) with Gravel	6.2	0.3798	1.1724	3.2161	8.47	1.13	100.0	100.0	96.9	95.0	84.8	74.1	42.9	11.8	1.8	0.0	25.9	72.2	1.7	4.1E-01	
2	Poorly Graded Sand (SP) with Gravel	5.6	0.5766	1.4565	3.4443	5.97	1.07	100.0	100.0	96.1	93.8	85.2	72.9	38.2	5.5	0.8	0.0	27.1	72.1	0.8	1.1E+00	
3	Well Graded Sand (SW)	7.5	0.3386	0.9936	2.6258	7.76	1.11	100.0	100.0	100.0	100.0	95.1	85.9	50.4	12.2	2.2	0.0	14.1	83.8	1.9	3.0E-01	
4	Poorly Graded Sand (SP) with Gravel	5.9	0.5081	1.2732	3.0405	5.98	1.05	100.0	100.0	100.0	95.9	89.7	78.9	42.5	7.3	1.3	0.0	21.1	77.6	1.2	5.9E-01	
5	Poorly Graded Sand (SP) with Gravel	6.0	0.5210	1.2514	2.9512	5.66	1.02	100.0	100.0	100.0	98.7	91.7	80.6	43.7	6.5	1.2	0.0	19.4	79.5	1.1	8.4E-01	
6	Well Graded Sand (SW) with Gravel	7.1	0.3792	1.0490	2.7409	7.23	1.06	100.0	100.0	97.7	94.4	90.1	81.6	47.6	11.0	2.2	0.0	18.4	79.3	2.1	3.6E-01	
7	Poorly Graded Sand (SP-SC) with Clay	23.1	0.0757	0.1599	0.5429	7.17	0.62	100.0	100.0	100.0	100.0	98.4	94.7	80.6	56.1	9.8	0.0	5.3	84.9	10.0	5.6E-02	
8	Well Graded Sand with Gravel (SW), gray	8.7	0.1868	0.8464	2.6959	14.44	1.42	100.0	100.0	100.0	99.5	94.8	84.4	47.1	17.1	2.1	0.0	15.6	82.4	2.1	3.0E-01	
9	Well Graded Sand (SW) with Gravel	5.4	0.3714	1.4341	3.9659	10.68	1.40	100.0	100.0	93.7	89.1	77.9	66.1	36.5	11.3	1.0	0.0	33.9	65.1	1.0	2.9E-01	
10	Well Graded Sand (SW) with Gravel	4.4	0.2954	1.3526	4.3012	14.56	1.44	100.0	100.0	94.8	87.9	76.3	63.1	36.3	12.3	1.4	0.0	36.9	61.7	1.4	1.7E-01	
11	Well Graded Sand (SW) with Gravel	4.4	0.3771	1.1624	3.2364	8.58	1.11	100.0	100.0	100.0	96.3	87.8	75.2	41.0	10.6	1.8	0.0	24.8	73.3	1.8	3.9E-01	
12	Poorly Graded Sand (SP) with Gravel	2.7	0.4552	1.1566	3.1130	6.84	0.94	100.0	100.0	97.9	96.4	86.8	76.9	42.4	8.5	1.4	0.0	23.1	75.5	1.4	4.7E-01	
13	Well Graded Sand (SW) with Gravel	12.5	0.1642	0.7368	2.4777	15.09	1.33	100.0	100.0	100.0	100.0	93.1	84.1	53.4	20.4	3.7	0.0	15.9	80.4	3.7	2.4E-01	
14	Well Graded Sand (SW-SC) with Clay and Gravel	14.0	0.1021	0.9001	3.1464	30.82	2.52	100.0	90.3	90.3	89.1	84.2	75.4	44.5	20.0	7.8	0.0	24.6	67.6	7.8	2.5E-01	CH
15		7.7	0.1110	0.6950	2.4690	22.24	1.76	100.0	100.0	100.0	99.1	93.7	83.3	53.8	21.7	6.6	0.0	16.7	76.7	6.6		
16		8.4	0.0934	0.6601	2.3445	25.10	1.99	100.0	100.0	100.0	100.0	95.3	86.1	54.9	22.4	8.4	0.0	13.9	77.7	8.4		
17		6.8	0.1413	0.7713	2.6062	18.44	1.62	100.0	100.0	100.0	98.3	93.1	81.3	51.6	20.1	6.1	0.0	18.7	75.2	6.1		
18	Silty Sand (SM), with Gravel	8.5						100.0	100.0	94.4	91.5	85.3	76.4	49.5	46.6	33.3	0.0	23.6	43.1	33.3	8.6E-02	
19		8.2	0.1425	0.7675	2.6682	18.72	1.55	100.0	100.0	100.0	98.5	90.6	81.2	50.8	19.8	6.1	0.0	18.8	75.1	6.1		
20	Silty Sand (SM), gray	13.3						100.0	100.0	100.0	100.0	94.3	87.5	61.4	30.9	14.3	0.0	12.5	73.2	14.3	1.9E-02	
21	Silty Sand (SM), gray	16.8						100.0	100.0	100.0	100.0	96.5	89.5	62.2	34.4	17.1	0.0	10.5	72.4	17.1	1.8E-02	
22	Well Graded Sand (SW-SM) with Silt and Gravel	5.8	0.1552	1.0052	2.9060	18.73	2.24	100.0	100.0	100.0	97.1	93.3	84.0	43.5	18.6	5.6	0.0	16.0	78.4	5.6		ML
23	Well Graded Sand (SW-SM) with Silt and Gravel	6.8	0.1053	0.6226	2.6016	24.71	1.42	100.0	100.0	100.0	97.0	89.4	81.0	52.3	23.5	6.7	0.0	19.0	74.3	6.7		ML
24	Well Graded Sand (SW-SM) with Silt	4.5	0.1541	0.8266	2.6141	16.96	1.70	100.0	100.0	100.0	97.7	92.9	86.8	49.2	19.4	5.3	0.0	13.2	81.5	5.3		ML
25	Well Graded Sand (SW-SM) with Silt and Gravel	6.8	0.0972	0.5461	2.4056	24.74	1.28	100.0	100.0	98.4	96.7	90.2	81.0	54.5	26.1	7.2	0.0	19.0	73.8	7.2		ML
	max		0.5766	1.4565	4.3012	30.82	2.52	100.0	100.0	100.0	100.0	98.4	94.7	80.6	56.1	33.3	0.0	36.9	84.9	33.3	1.1E+00	
	min		0.0757	0.1599	0.5429	5.66	0.62	100.0	90.3	90.3	87.9	76.3	63.1	36.3	5.5	0.8	0.0	5.3	43.1	0.8	1.8E-02	
	average		0.2605	0.9472	2.8233	14.50	1.40	100.0	99.6	98.4	96.5	90.0	80.5	49.2	19.8	6.2	0.0	19.5	74.3	6.2	3.5E-01	

LANDFILL RUNOFF COLLECTION POND

FLY ASH DAM GEOTECHNICAL ANALYSIS

PARAMETER DERIVATION

I. Subsurface Exploration Program Development:

The scope determined two sections across the dam. Two borings will be drilled on each section, on the crest and at the toe, only Sheby tube samples were collected that will be used to supplement available historic borings data in the development of the soil profile.

II. Laboratory Testing Program:

The program was developed to provide additional soil data to available historic data.

- USCS Soil Classification Tests.
- Triaxial tests.
- Permeability tests
- Moisture-density tests.

III. Geotechnical Analysis:

A soil tests summary was developed to select soil parameters to use in the geotechnical analysis. Engineering properties that were not directly tested were determined using typical soil parameter values from NAVFAC DM7-02 Foundations and Earth Structures (Table 1 on Page 39) and the Center For Geotechnical Practice and Research, Performance and Use of the Standard Penetration Test in Geotechnical Engineering Practice report (Figures 34 and 35 on pages 72 and 77 respectively). The two tables are attached at the end of the parameter derivation notes.

Permeability k values that were not tested in the laboratory were selected from typical values provided in the table below and those provided in NAVFAC DM7.02, table 1: Typical Properties of Compacted soils

Soil Type	k_v(cm/s)
Coarse Sand	$>10^{-1}$
Fine Sand	10^{-1} to 10^{-3}
Silty Sand	10^{-3} to 10^{-5}
Silt	10^{-5} to 10^{-7}
Clay	$<10^{-7}$

Historic boring and graphic logs were used to develop the dam's soil horizons for soil layers on which soil sampling was not done.

Soils from the Flay Ash Dam were classified into 7 main soil layers.

The following table shows how pertinent parameters were selected and which sections they were applied to.

Soil name	USGS class	Classification Samples	Shear results sample	Permeability k-value sample	Section
Embankment fill	**CL**	B-9 sample (20.2' – 20.8')	Average Triaxial Test B-7 & B-9	Average K tests B-7 & B-9	D/E
Lean Clay With Sand	**CL**	B-8 sample (25.5' – 25.8')	Average Triaxial Test B-8 & B-10	Permeability test B-8	D/E
Clayey Sand and Gravel	**GC**	Fly Ash Dam Raising report logs	Typical values *	Typical values *	D
Sandy Silts	**ML**	Fly Ash Dam Raising report logs	Typical values *	Typical values *	D
Silty Clay With Sand	**CL-ML**	B-10 sample (16.2' – 16.8')	Typical values *	Permeability test B-10	E
Silty Sand	**SM**	B-10 sample (14.2' – 14.8')	Typical values *	Typical values *	D/E
Fly Ash	**NA**	NA	Typical values *	Hydrogeologic study report	D/E

* Typical values as determined from referenced tables.

Soil name	Unit Weight	C	ϕ	kv (cm/sec)	Typical kh/kv	g	e
Embankment fill	129	198	27.5	7.30E-08	10	2.63 B-7 (27.2-27.8)	0.609 (ST sample)
Lean Clay With Sand	127	205.92	28	3.40E-08	10	2.65 B-8 (29.7-30.3)	0.700 (ST sample)
Clayey Sand and Gravel	130	0	35	1.00E-02	10	2.70	0.5
Sandy Silts	125	0	30	1.00E-04	5	2.65 B-8 (29.7-30.3)	0.4
Silty Clay With Sand	118	151.92	34.1	1.40E-07	10	2.68 B-10 (14.2-14.8)	0.43

Silty Sand	94	0	30	1.00E-04	5	2.66 B-10 (16.2-16.8)	0.4
Fly Ash	115	0	25	4.75E-04	50	NA	NA

1. SEEPAGE ANALYSIS.

Geoslope Seep W analysis was used to analyze the model for seepage. Historic Field piezometer readings (Hydrogeologic Study Report, Clifty Creek Coal Ash Landfill, AGES. November 2006) were compared to the model's results. The model results were inconsistent with available piezometer readings. This was due to a lack of enough soil property data.

Water elevations used were:
- Existing (normal) water elevation in the pond: 485 feet.
- Ohio River water elevation 426 feet.

Seepage analysis results were not used in slope stability analyses.

2. STABILITY ANALYSIS.

Geoslope Slope W was used for the slope stability analysis.

The Spencer Analysis Method was used.

Slip circle method and siding wedge method were modeled by the circular failure plane and the block specified; the circular failure plane produced lower Factors of Safety.

The peak ground acceleration used for the seismic analysis was obtained from US Geological Survey website. The PGA used is 0.08g. The method selected to do the seismic analysis was the pseudostatic analysis per the project scope.

Loading conditions:

During a period from 2004 to 2006, groundwater readings from different piezometers and wells across the dam and toe area were taken. The results of these readings provide were used for steady state analysis. (Hydrogeologic Study Report, Clifty Creek Coal Ash Landfill, AGES. November 2006)

Static Slope Stability Loading Conditions:
- Steady state Seepage normal pool (upstream and downstream slopes): 485 feet
- PMF event (upstream and downstream slopes). The flood water was considered as a surcharge above the water pool for steady state. PMF event water elevation in the pond: 501.4 feet.

Seismic Slope Stability Loading Conditions:
- Steady state seepage normal pool (upstream and downstream slopes): 485 feet.

3. <u>LIQUEFACTION ANALYSIS</u>.

<u>Research and methodology:</u>

- Earthquake intensity: USGS website used to determine the Peak Ground Acceleration and earthquake intensity for an earthquake event of a mean return period of 2,475 years. PGA = 0.07677g (used 0.08g) and M_L = 7.7.

- Groundwater elevation date from 2004 through 2006 provide a steady state water elevation through the dam and the foundation soil materials. Unsaturated soil located above the groundwater table will not liquefy.

- Soil Type:

  The dam soil materials, being constructed of engineered fill are not considered liquefiable.

  Cohesionless materials are considered liquefiable. The majority of cohesive soils will not liquefy, cohesive soils susceptible to liquefy should have an liquid limit less than 37 and the water content of the soil must be greater than about 85% of the liquid limit.

  Due to the absence of USCS classification laboratory results, cohesive foundation materials were considered potentially liquefiable and Factors of Safety against liquefaction were calculated.

- Soil relative density (Dr): Soils in a loose relative density state are susceptible to liquefaction. Soils with an SPT-N value of 30 or higher were considered not liquefiable.

<u>Liquefaction Assessment</u>

Data from nine historical borings (SI-1, SS1-1, SS2-1, SS2-4, SS3-1, SS3-4, SS4-1, SS4-4, and SS5-1) were used to assess liquefaction potential. These borings were drilled in 1984 as part of the AEP Fly Ash Dam Raising Feasibility Project (1985). Soil characteristics included on the borings include the visually-estimated soil classifications per the USCS and SPT N-values.

In order to analyze the dam and foundation materials against liquefaction, it was necessary to assume the percent fines, or percent silt and clay, for many of the soils due to lack of particle size distribution data for the historic borings. Correlating current laboratory classification results with historic logs was done and where data was not available, typical values were assumed based on the visual USCS classifications on the historical boring logs.

Method Used: Simplified Method based on using correlations to blow counts from Standard Penetration Tests (SPTs) as set forth in Youd et al (2001) and discussed in NRC (1985).

The Simplified Method requires estimating the Cyclic Stress Ratio (CSR) and Cyclic Resistance Ratio (CRR) of the soil. The CRR can be estimated using information from SPT tests, corrected to account for various effects. To use the Simplified Method, the SPT N value is normalized to an overburden pressure of approximately 100 kiloPascals (kPa) and a hammer energy ratio of 60% and procedural effects (rod length, sample configuration and borehole diameter).

The $(N_1)_{60}$ may also be corrected for the percent of fines using the relationship:

$$(N_1)_{60cs} = \alpha + \beta(N_1)_{60}$$

It is important to note that the fines correction is an approximation and is only valid for nonplastic fines and with a fines content between 0 and 35%. This correction factor, although widely used, is considered as a rough approximation only.

Once the corrected value for $(N_1)_{60}$ is found, the CRR is calculated as:

$$CRR_{7.5} = \frac{1}{34-(N_1)_{60}} + \frac{(N_1)_{60}}{135} + \frac{50}{[10*(N_1)_{60}+45]^2} - \frac{1}{200}$$

Note that the value calculated is the CRR normalized to a 7.5 magnitude earthquake, hence the $CRR_{7.5}$ notation. When evaluating the liquefaction potential of soil, the $CRR_{7.5}$ must be corrected to the magnitude earthquake of interest.

The CSR is independent of soil properties and may be approximated using the equation:

$$CSR = 0.65(\frac{a_{max}}{g})(\frac{\sigma_v}{\sigma_v'})r_d$$

where:

a_{max} is the maximum ground acceleration.
g is the acceleration of gravity.
σ_v is the total vertical stress.
σ_v' is the effective vertical stress.
r_d is a stress reduction coefficient.

Liquefaction potential for a soil unit is evaluated by dividing $CRR_{7.5}$ by CSR and then correcting to the magnitude earthquake of interest, as:

$$FS = \frac{CRR_{7.5}}{CSR} * MSF$$

Field experience has shown that the Simplified Method is somewhat conservative; so many designers consider FS values close to unity as an indication of no liquefaction.

SI-1

Elevation	Depth	Soil class	N	Remarks
452.8	3.75	SC	16	Not liquefiable, above ground water.
447.8	8.75	SC	13	
442.8	13.75	ML	8	
437.8	18.75	ML	5	Evaluated for liquefaction
432.8	23.75	ML	9	
427.8	28.75	SC	23	
422.8	33.75	SC	24	
417.8	38.75	SM	22	
412.8	43.75	ML	18	
407.8	48.75	ML	28	
402.8	53.75	ML	22	
397.8	58.75	ML	12	
392.8	63.75	ML	9	
387.8	68.75	ML	14	
382.8	73.75	ML	21	
377.8	78.75	ML	50	

SS1-1

Elevation	Depth	Soil class	N-field	Remarks
502.3	3.25	CL	17	Not liquefiable Embankment as layer is above ground water
497.3	8.25	CL	12	
492.3	13.25	CL	17	
487.3	18.25	CL	15	
482.3	23.25	CL-ML	17	
477.3	28.25	CL	15	
472.3	33.25	CL	21	
467.3	38.25	CL	23	
462.3	43.25	ML	30	
457.3	48.25	ML	24	Evaluated for liquefaction
452.3	53.25	CL	23	
447.3	58.25	CL	35	
442.3	63.25	CL	27	
437.3	68.25	SC	8	
432.3	73.25	CL	20	
427.3	78.25	CL	24	
422.3	83.25	CL	30	
417.3	88.25	SC	46	

SS2-1

Elevation	Depth	Soil class	N-field	Remarks
500.7	3.75	CL	10	Not liquefiable. Embankment and located above ground water
495.7	8.75	CL	12	
490.7	13.75	CL	13	
485.7	18.75	CL-ML	26	
480.7	23.75	CL	14	
475.7	28.75	CL	17	
470.7	33.75	CL	24	
465.7	38.75	CL	25	
460.7	43.75	CL	13	
455.7	48.75	CL	14	Evaluated for liquefaction
450.7	53.75	CL	24	
445.7	58.75	CL	26	
440.7	63.75	ML	26	
435.7	68.75	CL	13	
430.7	73.75	SM	12	
425.7	78.75	SM	43	
420.7	83.75	SM	28	
415.7	88.75	CL	22	
410.7	93.75	CL	29	

SS2-4

Elevation	Depth	Soil class	N-field	Remarks
436.6	3.25	CL	13	Evaluated for liquefaction
431.6	8.25	CL	12	
426.6	13.25	CL	8	
421.6	18.25	SM	12	
416.6	23.25	CL	6	
411.6	28.25	CL	17	
406.6	33.25	CL	17	
401.6	38.25	CL	15	
396.6	43.25	CL	11	
391.6	48.25	CL	12	
386.6	53.25	CL	13	
381.6	58.25	CL	19	
376.6	63.25	GC	22	

SS3-1

Elevation	Depth	Soil class	N-field	Remarks
501.2	3.25	CL	11	Not liquefiable. Embankment and located above ground water
496.2	8.25	CL-ML	12	
491.2	13.25	CL	22	
486.2	18.25	ML	17	
481.2	23.25	CL	22	
476.2	28.25	SC	27	Evaluated for liquefaction
471.2	33.25	CL	10	
466.2	38.25	ML	15	
461.2	43.25	ML	22	
456.2	48.25	SP	24	
451.2	53.25	SC	33	
446.2	58.25	SP	17	
441.2	63.25	SP	20	
436.2	68.25	SM	25	
431.2	73.25	SP	14	
426.2	78.25	SP	37	
421.2	83.25	SP	28	
416.2	88.25	SM	29	
411.2	93.25	SM	28	
406.2	98.25	CL	29	

SS3-4

Elevation	Depth	Soil class	N-field	Remarks
448.1	3.75	CL	10	Not liquefiable, above ground water
443.1	8.75	CL	11	
438.1	13.75	SM	5	Evaluated for liquefaction
433.1	18.75	SM	7	
428.1	23.75	SC	2	
423.1	28.75	ML	11	
418.1	33.75	ML	9	
413.1	38.75	CL	2	
408.1	43.75	CL	19	
403.1	48.75	CL	22	
398.1	53.75	CL	15	
393.1	58.75	CL	16	
388.1	63.75	CL	19	
383.1	68.75	CL	21	
378.1	73.75	CL	20	
373.1	78.75	CL	34	

SS4-1

Elevation	Depth	Soil class	N-field	Remarks
502.4	3.25	CL	5	Not liquefiable. Embankment and above ground water
497.4	8.25	ML	23	
492.4	13.25	CL	13	
487.4	18.25	CL	24	
482.4	23.25	CL	17	
477.4	28.25	CL	19	
472.4	33.25	CL	20	
467.4	38.25	CL	16	Evaluated for liquefaction
462.4	43.25	ML	17	
457.4	48.25	SM	11	
452.4	53.25	SM	23	
447.4	58.25	SM	18	
442.4	63.25	SM	24	
437.4	68.25	CL	26	
432.4	73.25	SC	5	
427.4	78.25	ML	22	
422.4	83.25	ML	29	
417.4	88.25	ML	30	
412.4	93.25	ML	30	

SS4-4

Elevation	Depth	Soil class	N-field	Remarks
447.0	3.75	CL	13	Not liquefiable, above ground water
442.0	8.75	CL	7	
437.0	13.75	SM	2	Evaluated for liquefaction
432.0	18.75	CL	4	
427.0	23.75	GC	50	
422.0	28.75	GC	29	

SS5-1

Elevation	Depth	Soil class	N-field	Remarks
501.6	3.25	CL	8	Not liquefiable, Embankment and above ground water N-values more than 30.
496.6	8.25	CL	20	
491.6	13.25	CL	20	
486.6	18.25	SC	22	
481.6	23.25	SM	25	
476.6	28.25	SM	50	
471.6	33.25	SM	50	
466.6	38.25	SM	50	

TABLE 1
Typical Properties of Compacted Soils

Group Symbol	Soil Type	Range of Maximum Dry Unit Weight, pcf	Range of Optimum Moisture, Percent	Typical Value of Compression: At 1.4 tsf (20 psi) — Percent of Original Height	Typical Value of Compression: At 3.6 tsf (50 psf) — Percent of Original Height	Typical Strength Characteristics: Cohesion (as compacted) psf	Typical Strength Characteristics: Cohesion (saturated) psf	Typical Strength Characteristics: ∅ (Effective Stress Envelope Degrees)	Typical Strength Characteristics: Tan ∅	Typical Coefficient of Permeability ft./min.	Range of CBR Values	Range of Subgrade Modulus k lbs/cu in.
GW	Well graded clean gravels, gravel-sand mixtures.	125 - 135	11 - 8	0.3	0.6	0	0	>38	>0.79	5×10^{-2}	40 - 80	300 - 500
GP	Poorly graded clean gravels, gravel-sand mix	115 - 125	14 - 11	0.4	0.9	0	0	>37	>0.74	10^{-1}	30 - 60	250 - 400
GM	Silty gravels, poorly graded gravel-sand-silt.	120 - 135	12 - 8	0.5	1.1	.....	.....	>34	>0.67	$>10^{-6}$	20 - 60	100 - 400
GC	Clayey gravels, poorly graded gravel-sand-clay.	115 - 130	14 - 9	0.7	1.6	.....	.....	>31	>0.60	$>10^{-7}$	20 - 40	100 - 300
SW	Well graded clean sands, gravelly sands.	110 - 130	16 - 9	0.6	1.2	0	0	38	0.79	$>10^{-3}$	20 - 40	200 - 300
SP	Poorly graded clean sands, sand-gravel mix.	100 - 120	21 - 12	0.8	1.4	0	0	37	0.74	$>10^{-3}$	10 - 40	200 - 300
SM	Silty sands, poorly graded sand-silt mix.	110 - 125	16 - 11	0.8	1.6	1050	420	34	0.67	$5 \times >10^{-5}$	10 - 40	100 - 300
SM-SC	Sand-silt clay mix with slightly plastic fines.	110 - 130	15 - 11	0.8	1.4	1050	300	33	0.66	$2 \times >10^{-6}$	5 - 30	100 - 300
SC	Clayey sands, poorly graded sand-clay-mix.	105 - 125	19 - 11	1.1	2.2	1550	230	31	0.60	$5 \times >10^{-7}$	5 - 20	100 - 300
ML	Inorganic silts and clayey silts.	95 - 120	24 - 12	0.9	1.7	1400	190	32	0.62	$>10^{-5}$	15 or less	100 - 200
ML-CL	Mixture of inorganic silt and clay.	100 - 120	22 - 12	1.0	2.2	1350	460	32	0.62	$5 \times >10^{-7}$	.....	
CL	Inorganic clays of low to medium plasticity.	95 - 120	24 - 12	1.3	2.5	1800	270	28	0.54	$>10^{-7}$	15 or less	50 - 200
OL	Organic silts and silt-clays, low plasticity.	80 - 100	33 - 21	.....	.....	.....	.....	.....	.....	.....	5 or less	50 - 100
MH	Inorganic clayey silts, elastic silts.	70 - 95	40 - 24	2.0	3.8	1500	420	25	0.47	$5 \times >10^{-7}$	10 or less	50 - 100
CH	Inorganic clays of high plasticity	75 - 105	36 - 19	2.6	3.9	2150	230	19	0.35	$>10^{-7}$	15 or less	50 - 150
OH	Organic clays and silty clays	65 - 100	45 - 21	.....	.....	.....	.....	.....	.....	.....	5 or less	25 - 100

Notes:

1. All properties are for condition of "Standard Proctor" maximum density, except values of k and CBR which are for "modified Proctor" maximum density.
2. Typical strength characteristics are for effective strength envelopes and are obtained from USBR data.
3. Compression values are for vertical loading with complete lateral confinement.
4. (>) indicates that typical property is greater than the value shown.
   (..) indicates insufficient data available for an estimate.

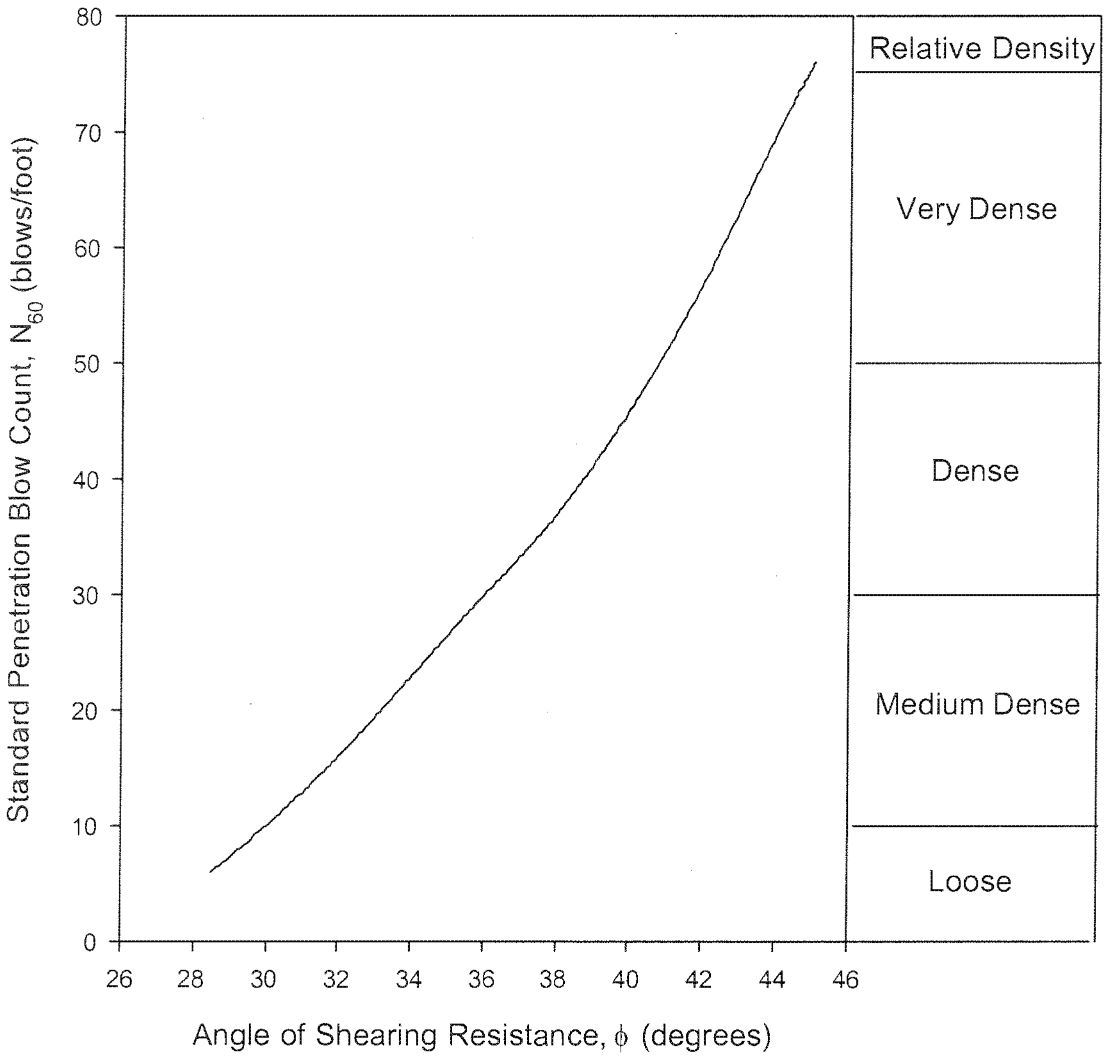


Figure 35. Estimation of the angle of shearing resistance of granular soils from standard penetration test results (Originally from Peck et al., 1974, modified by Carter and Bentley, 1991).

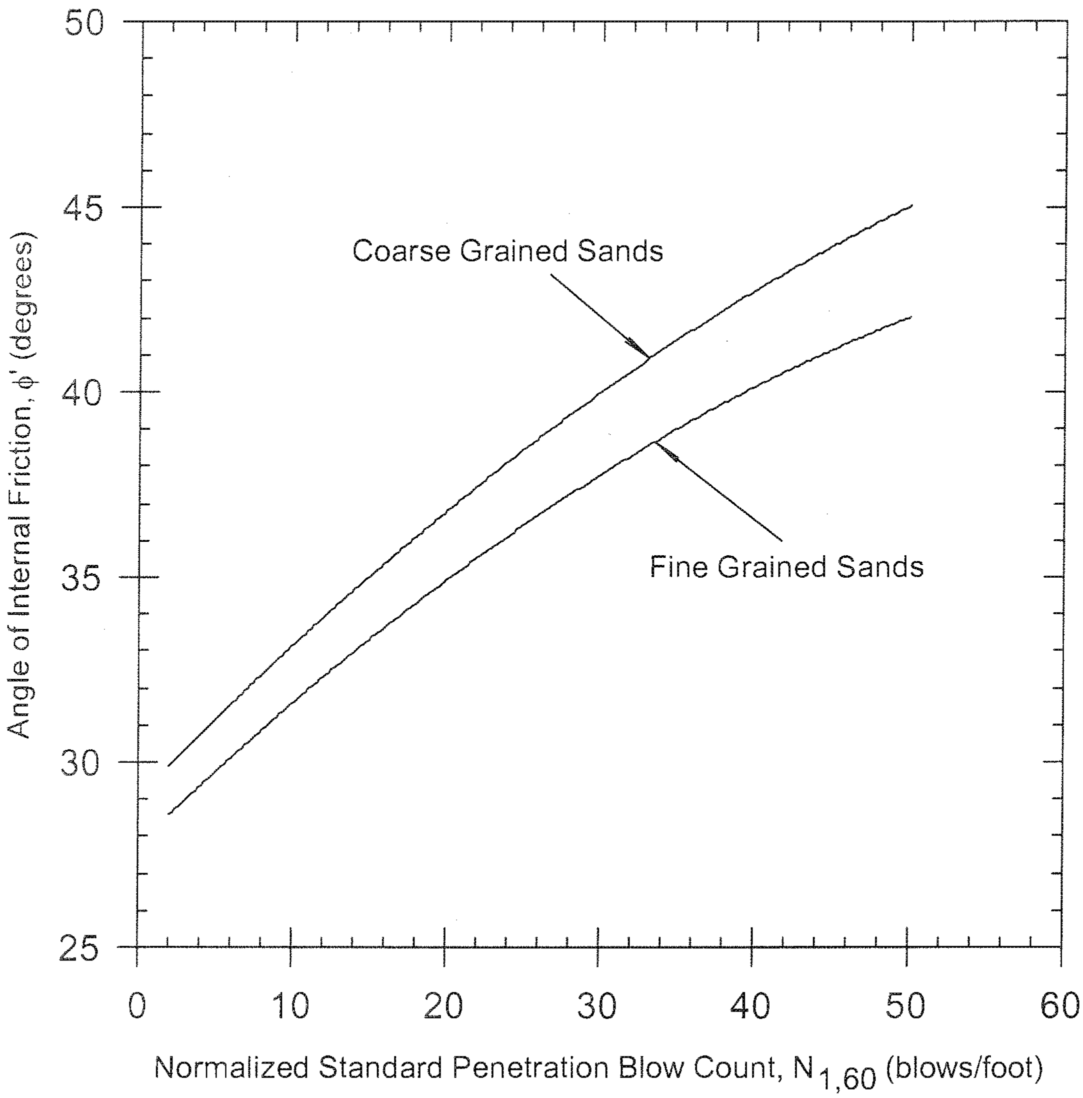
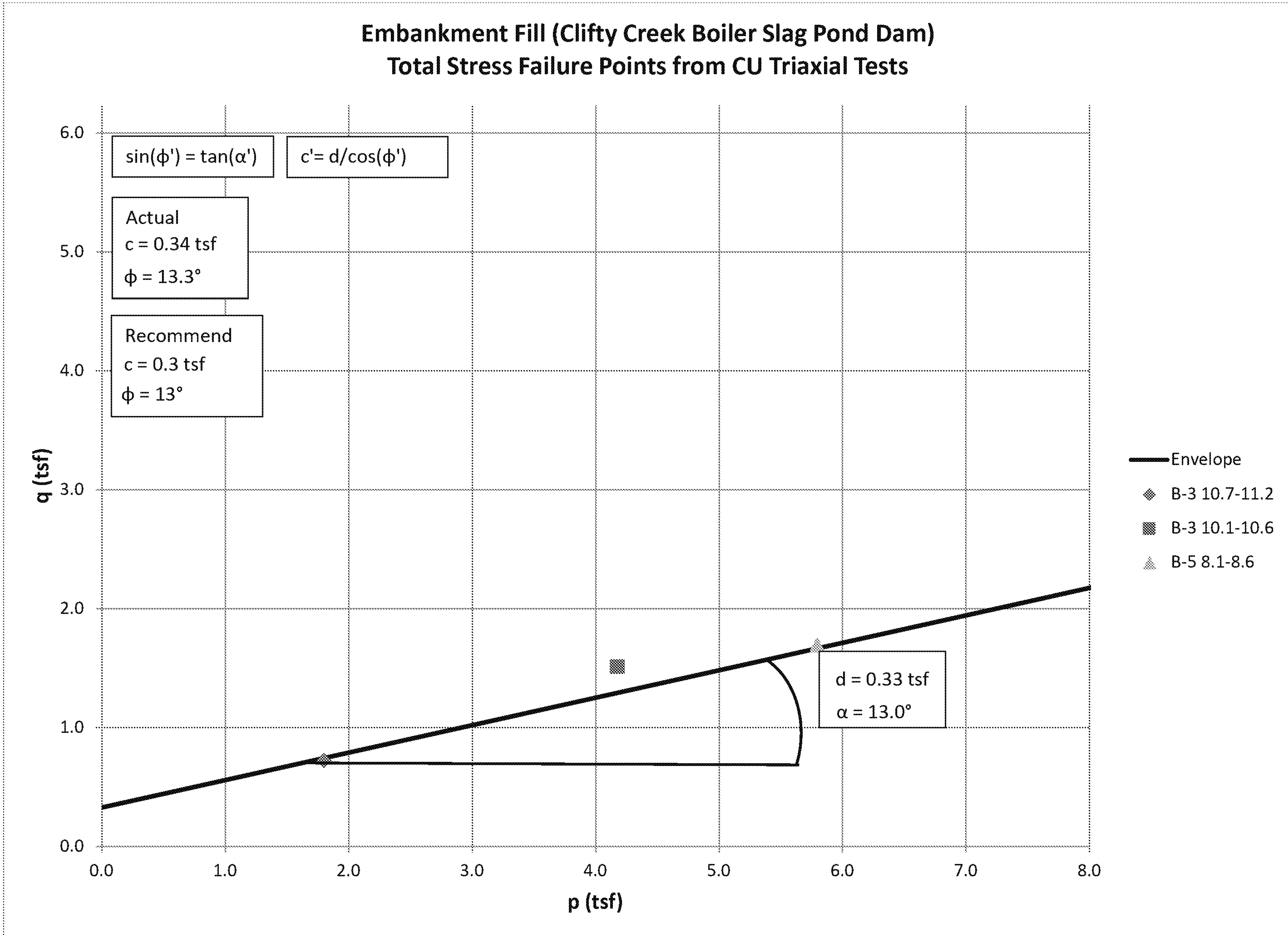
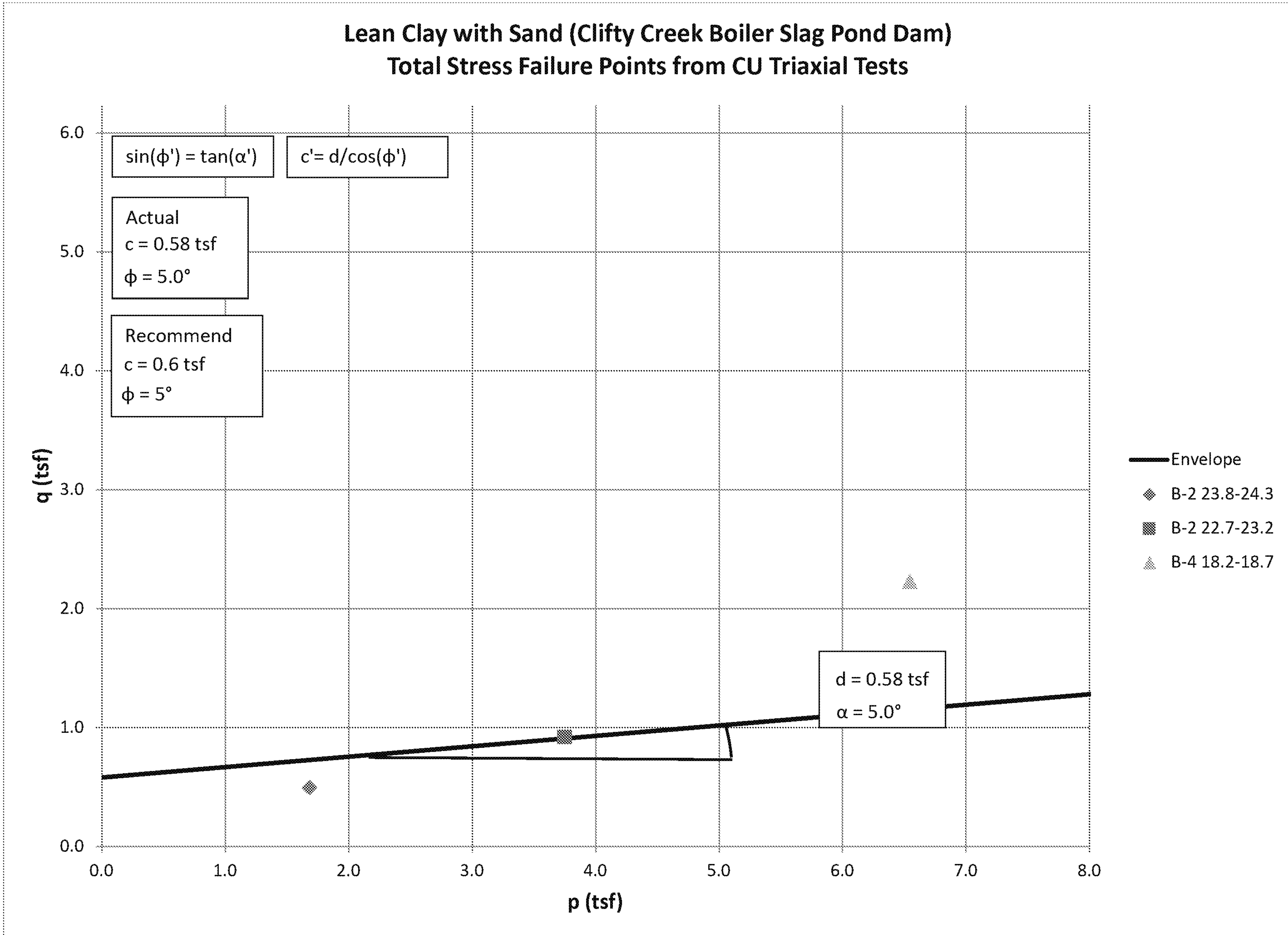


Figure 34. Empirical correlation between friction angle of sands and normalized standard penetration blow count (after Terzaghi et al., 1996)

UNDRAINED CALCULATIONS: BOILER SLAG POND DAM


Embankment Fill (Clifty Creek Boiler Slag Pond Dam)
Total Stress Failure Points from CU Triaxial Tests
sin(ϕ') = tan(α')
c'= d/cos(ϕ')
Actual
c = 0.34 tsf
ϕ = 13.3°
Recommend
c = 0.3 tsf
ϕ = 13°
d = 0.33 tsf
α = 13.0°
q (tsf)
p (tsf)
0.0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
8.0
Envelope
B-3 10.7-11.2
B-3 10.1-10.6
B-5 8.1-8.6



Lean Clay with Sand (Clifty Creek Boiler Slag Pond Dam)
Total Stress Failure Points from CU Triaxial Tests
sin(ϕ') = tan(α')
c'= d/cos(ϕ')
Actual
c = 0.58 tsf
ϕ = 5.0°
Recommend
c = 0.6 tsf
ϕ = 5°
d = 0.58 tsf
α = 5.0°
q (tsf)
p (tsf)
Envelope
B-2 23.8-24.3
B-2 22.7-23.2
B-4 18.2-18.7

PLANT: CLIFTY CREEK
FACILITY: BOILER SLAG POND DAM

MATERIAL: EMBANKMENT FILL

$\sigma_1' - \sigma_3'$ (plot) (psi)	σ_3' (lab request) (psi)	σ_1' (psi)	u (plot) (psi)	σ_1 (psi)	σ_3 (psi)
20	10	30	5	35	15
42	20	62	17	79	37
47	30	77	27	104	57

MATERIAL: LEAN CLAY W/ SAND

$\sigma_1' - \sigma_3'$ (plot) (psi)	σ_3' (lab request) (psi)	σ_1' (psi)	u (plot) (psi)	σ_1 (psi)	σ_3 (psi)
14	10	24	7	31	17
26	20	46	19	65	39
62	30	92	30	122	60

CALCULATED BY: J. SWINDLER

Stantec

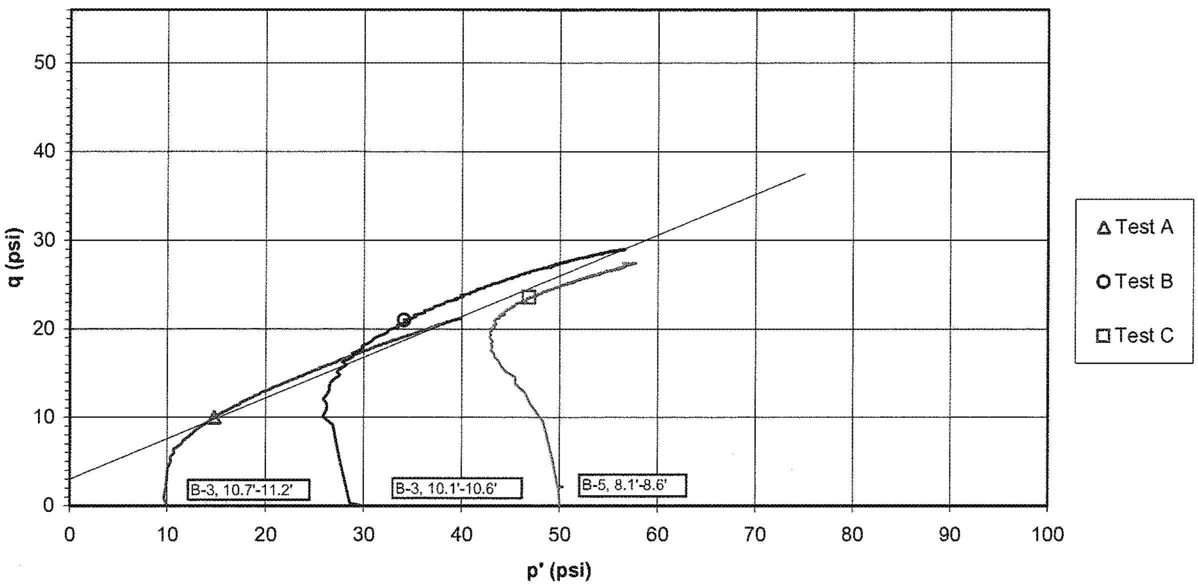
Consolidated Undrained Triaxial Test
ASTM D4767-04

Project	AEP-Clifty Creek-West Bottom and Fly Ash Ponds subsurface exploration	Project No.	175539022
Sample ID	B-3, 10.7'-11.2' & B-3, 10.1'-10.6' & B-5, 8.1'-8.6'	Test Number	1

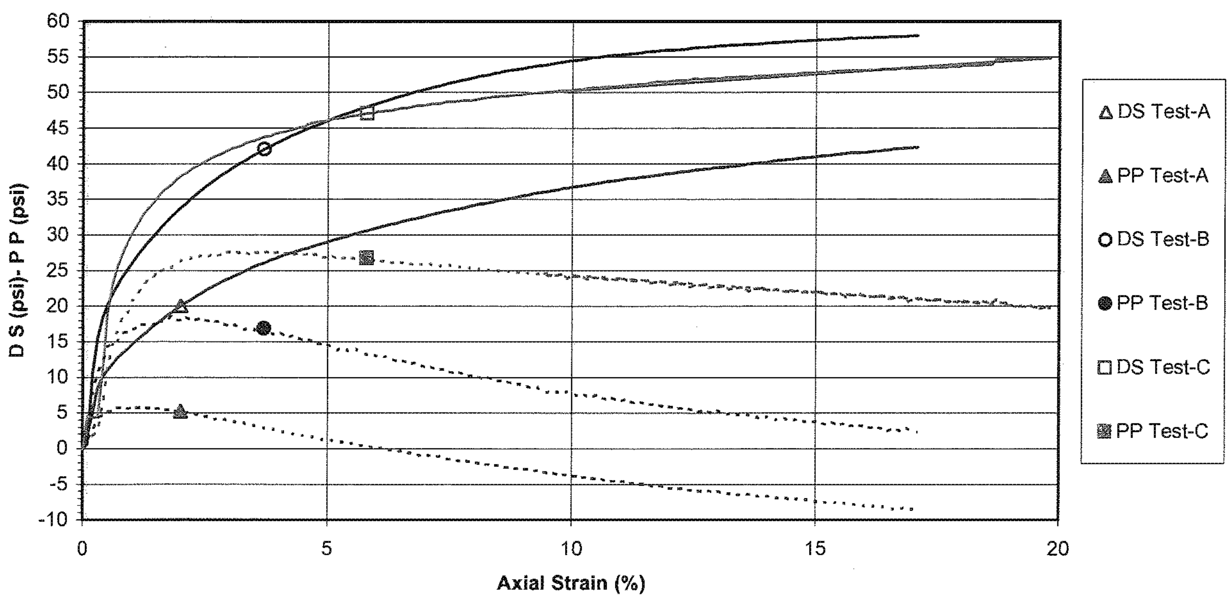
ϕ' = 27.4 deg. c' = 490 psf

Failure Criterion: Maximum Effective Principal Stress Ratio

p' vs. q Plot



Deviator Stress and Induced Pore Pressure vs. Axial Strain

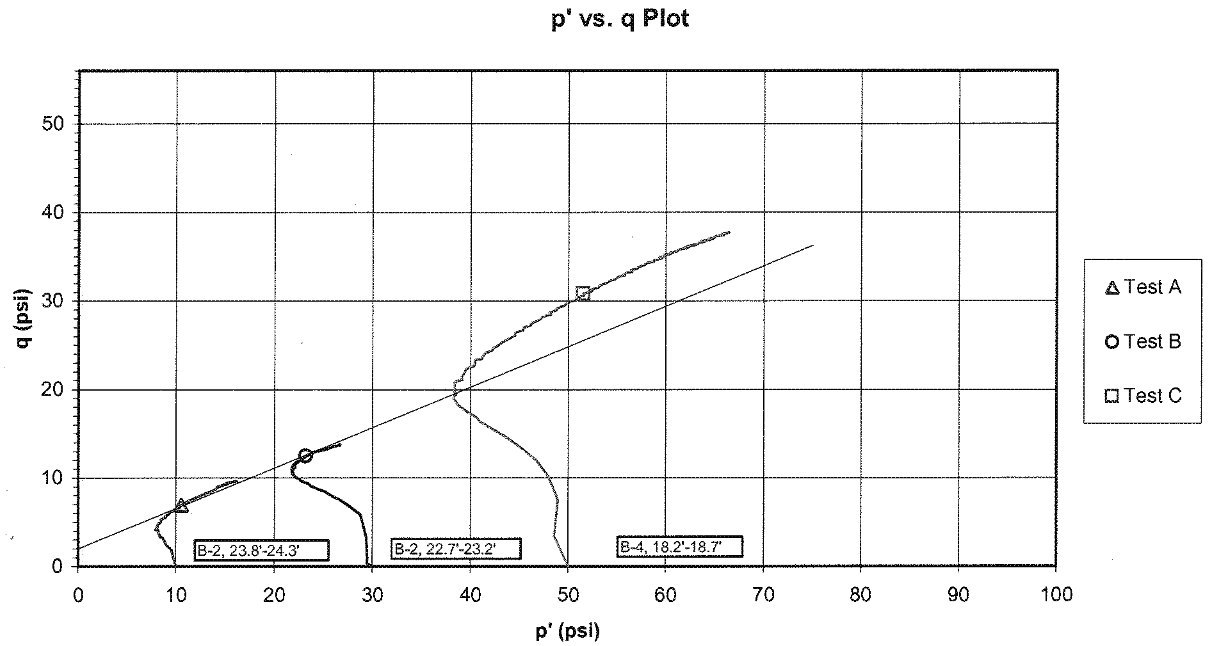


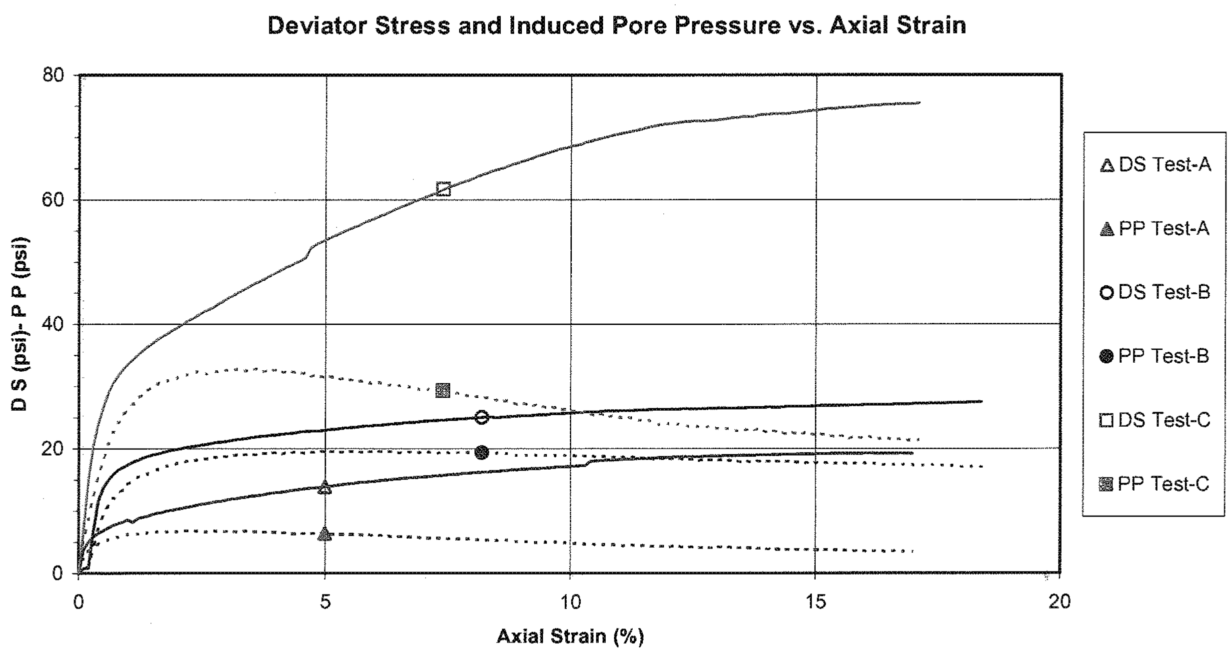
Stantec

Consolidated Undrained Triaxial Test
ASTM D4767-04

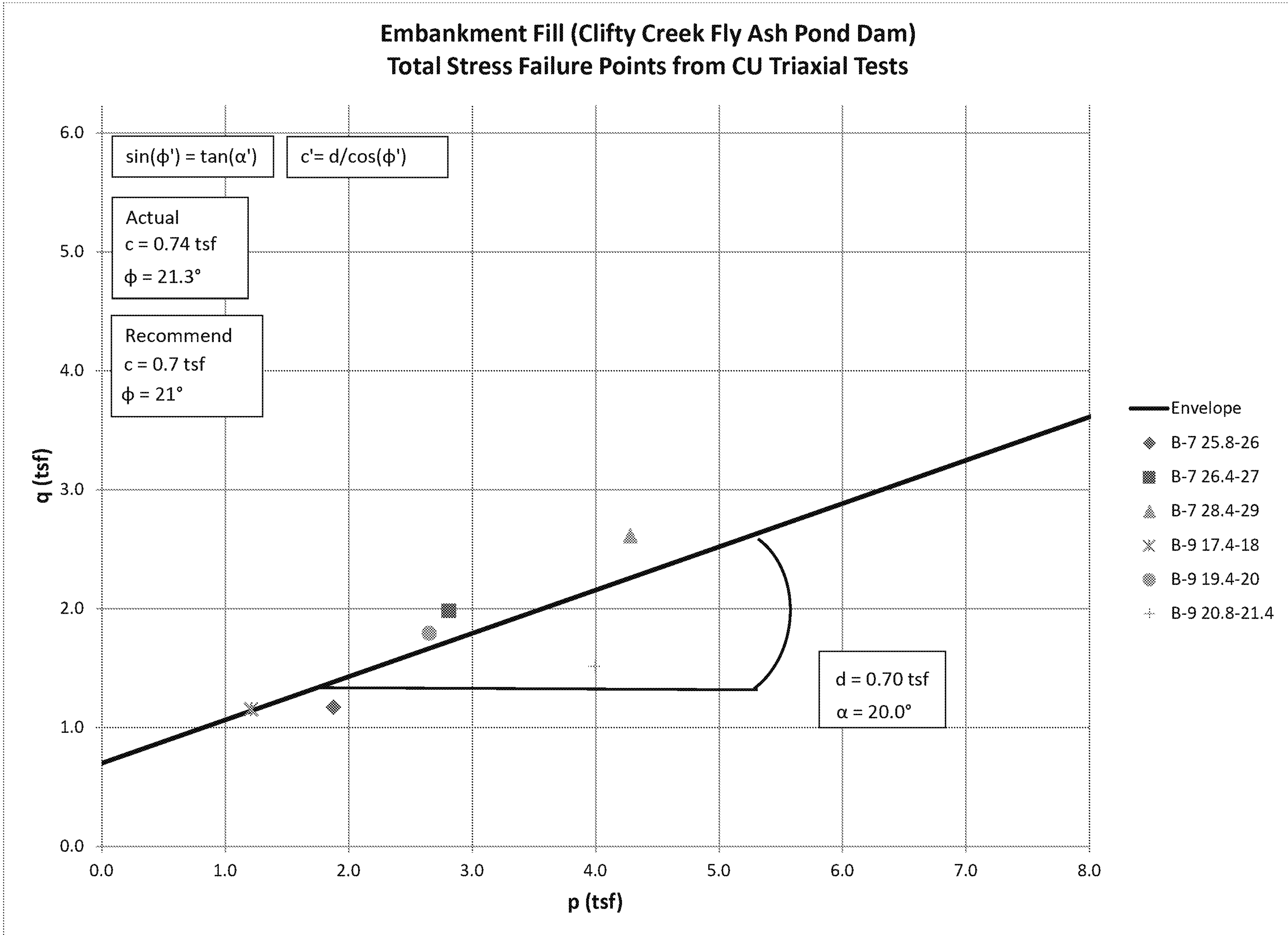
Project	AEP-Clifty Creek-West Bottom Ash and Fly Ash Ponds subsurface exploration	Project No.	175539022
Sample ID	B-2, 23.8'-24.3' & B-2, 22.7'-23.2' & B-4, 18.2'-18.7'	Test Number	2
	ϕ' = 27.2 deg.	c' =	320 psf

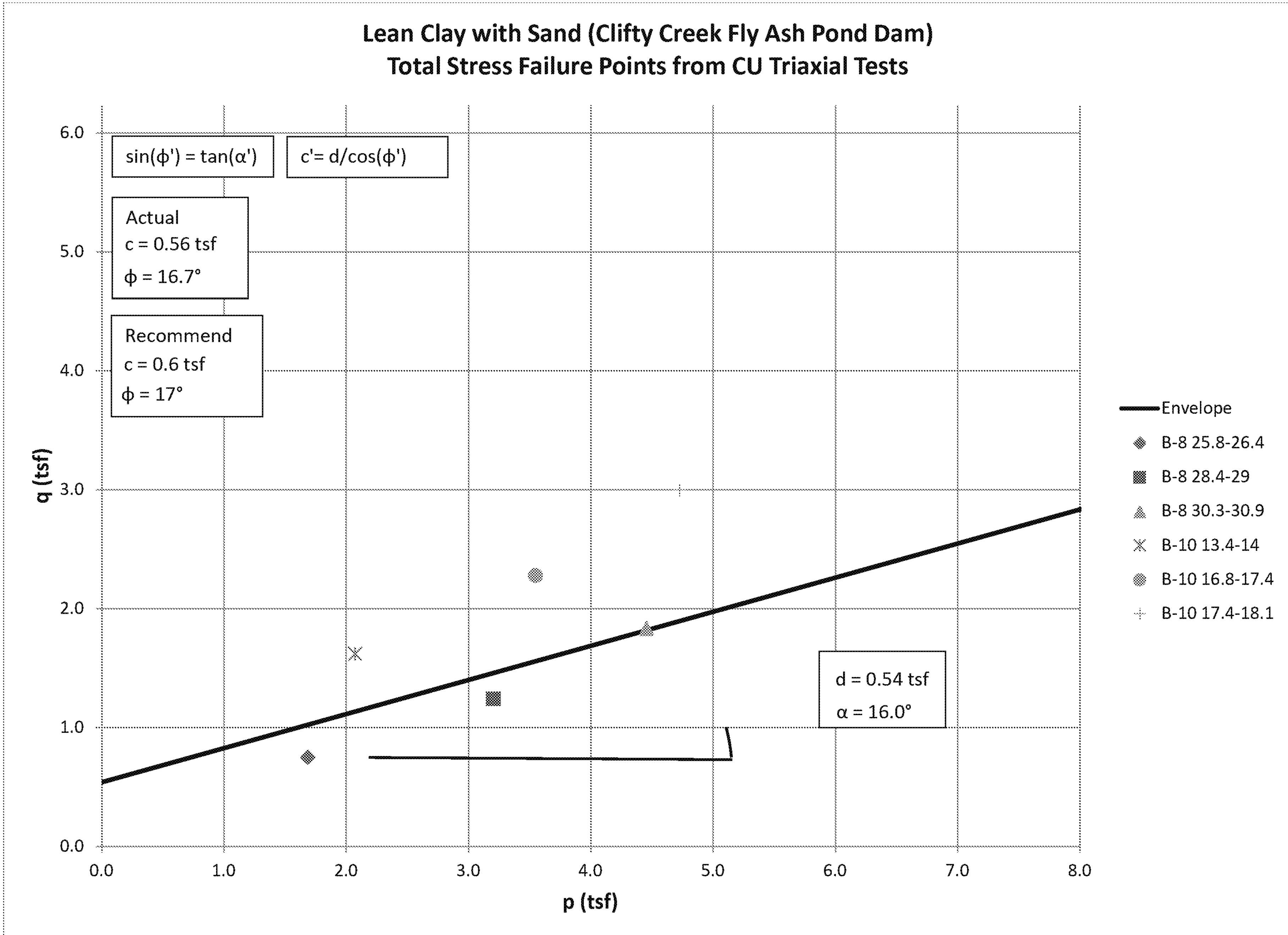
Failure Criterion: Maximum Effective Principal Stress Ratio





UNDRAINED CALCULATIONS: LANDFILL RUNOFF COLLECTION POND


Embankment Fill (Clifty Creek Fly Ash Pond Dam)
Total Stress Failure Points from CU Triaxial Tests
sin(ϕ') = tan(α')
c'= d/cos(ϕ')
Actual
c = 0.74 tsf
ϕ = 21.3°
Recommend
c = 0.7 tsf
ϕ = 21°
d = 0.70 tsf
α = 20.0°
q (tsf)
p (tsf)
6.0
5.0
4.0
3.0
2.0
1.0
0.0
0.0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
8.0
Envelope
B-7 25.8-26
B-7 26.4-27
B-7 28.4-29
B-9 17.4-18
B-9 19.4-20
B-9 20.8-21.4


Lean Clay with Sand (Clifty Creek Fly Ash Pond Dam)
Total Stress Failure Points from CU Triaxial Tests
sin(ϕ') = tan(α')
c'= d/cos(ϕ')
Actual
c = 0.56 tsf
ϕ = 16.7°
Recommend
c = 0.6 tsf
ϕ = 17°
d = 0.54 tsf
α = 16.0°
q (tsf)
p (tsf)
Envelope
B-8 25.8-26.4
B-8 28.4-29
B-8 30.3-30.9
B-10 13.4-14
B-10 16.8-17.4
B-10 17.4-18.1

Plant: Clifty Creek
Facility: Landfill Runoff Collection Pond

Material: Embankment

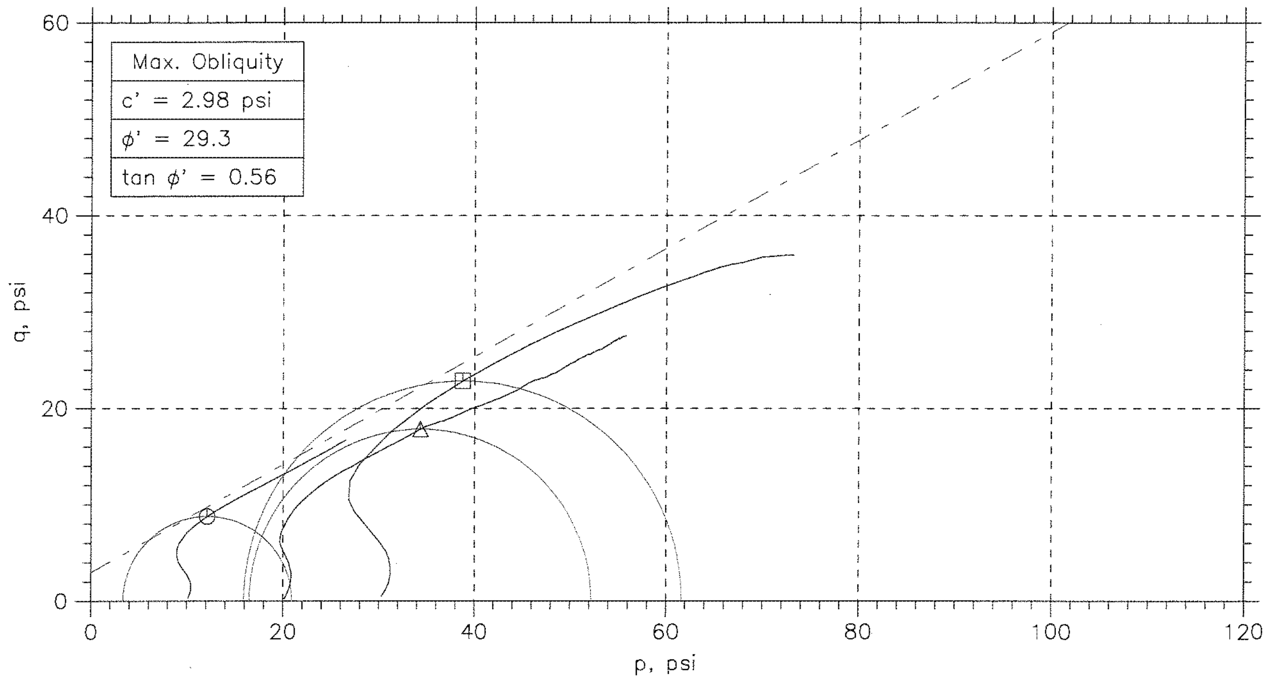
	$\sigma_1'-\sigma_3'$ (plot) (psi)	σ_3' (table) (psi)	σ_1' (psi)	u (plot) (psi)	σ_1 (psi)	σ_3 (psi)
B-7	32.50	9.83	42.33	0.00	42.33	9.83
B-7	55.00	19.88	74.88	-8.33	66.55	11.55
B-7	72.50	29.80	102.30	-6.57	95.73	23.23
B-9	32.00	10.00	42.00	-9.15	32.85	0.85
B-9	49.81	19.96	69.77	-8.00	61.77	11.96
B-9	42.00	29.88	71.88	4.62	76.50	34.50

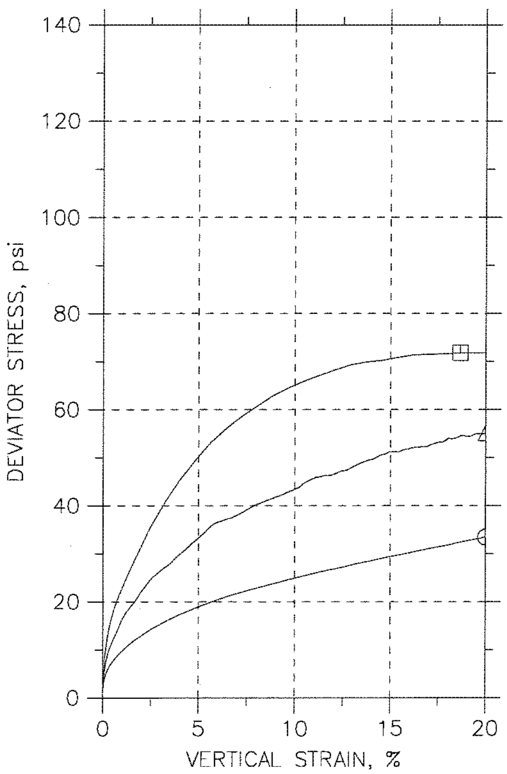
Material: Lean Clay with Sand

	$\sigma_1'-\sigma_3'$ (plot) (psi)	σ_3' (table) (psi)	σ_1' (psi)	u (plot) (psi)	σ_1 (psi)	σ_3 (psi)
B-8	20.84	9.97	30.81	3.05	33.86	13.02
B-8	34.42	19.98	54.42	7.30	61.72	27.28
B-8	50.88	29.96	80.84	6.50	87.34	36.46
B-10	45.00	10.00	55.00	-3.72	51.28	6.28
B-10	63.26	19.99	83.25	-2.33	80.92	17.66
B-10	83.26	30.00	113.26	-6.00	107.26	24.00

Calculated By: J. Swindler

CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767





Symbol		○	△	□	
Sample No.		---	---	---	
Test No.		1.1	1.2	1.3	
Depth		25.8-26.0	26.4-27.0	28.4-29.0	
Initial	Diameter, in	2.835	2.834	2.832	
	Height, in	6.314	5.928	5.929	
	Water Content, %	20.2	21.0	19.0	
	Dry Density, pcf	109.	107.5	111.3	
	Saturation, %	99.8	99.6	99.7	
	Void Ratio	0.546	0.568	0.515	
Before Shear	Water Content, %	21.0	21.6	19.1	
	Dry Density, pcf	107.7	106.5	111.2	
	Saturation*, %	100.0	100.0	100.0	
	Void Ratio	0.566	0.583	0.515	
	Back Press., psi	137.2	125.1	116.2	
Ver. Eff. Cons. Stress, psi		9.834	19.88	29.8	
Shear Strength, psi		16.74	27.57	35.9	
Strain at Failure, %		20	20	18.7	
Strain Rate, %/min		0.08	0.08	0.08	
B-Value		0.96	0.95	0.95	
Estimated Specific Gravity		2.7	2.7	2.7	
Liquid Limit		---	---	---	
Plastic Limit		---	---	---	

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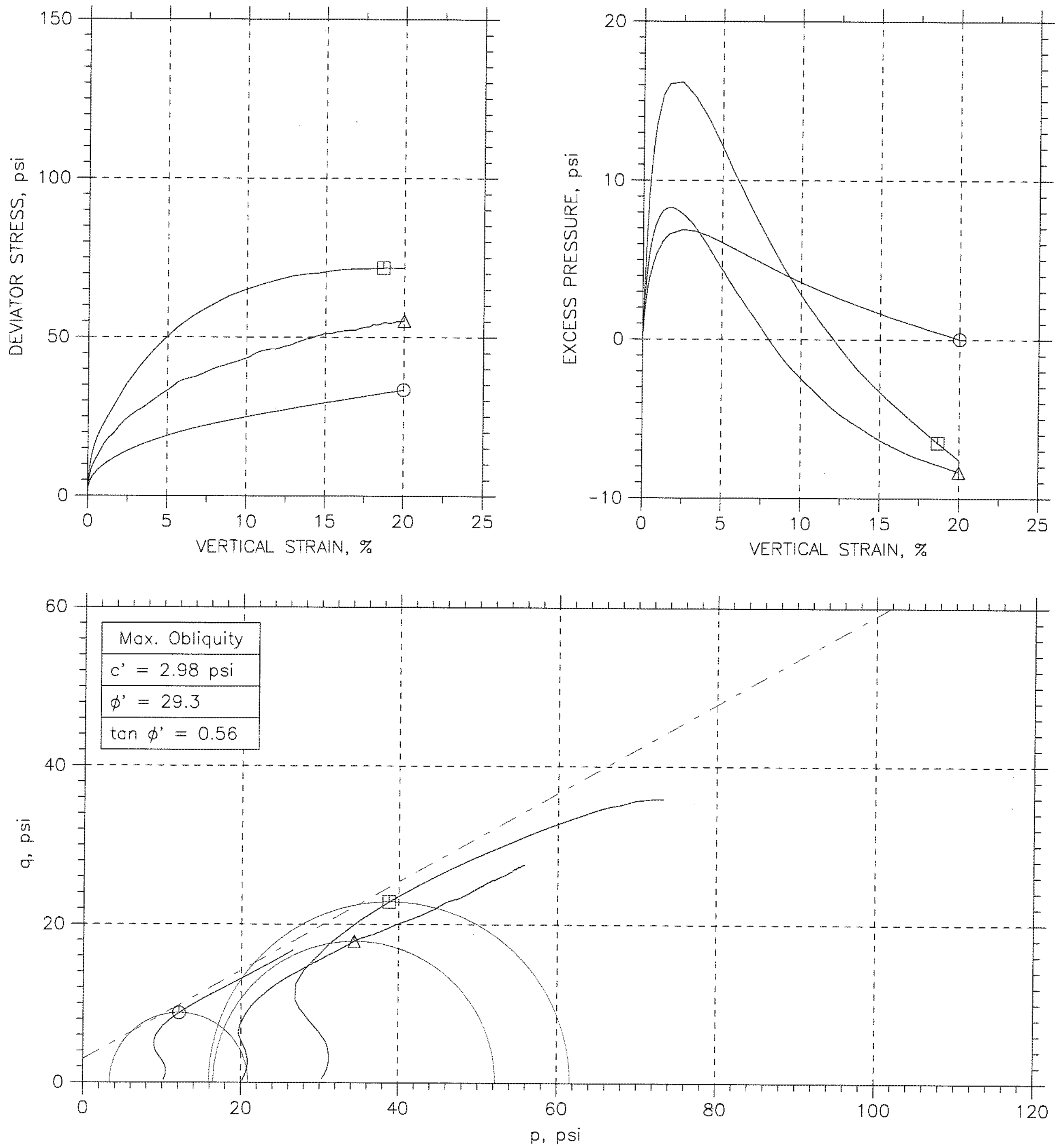
Project: Clifty Creek
Location: Jefferson, IN
Project No.: GTX-1516
Boring No.: B-7
Sample Type: UD
Description: Light Brown
Remarks: System 1062

Mon, 18-JAN-2010 16:57:15

CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767



	Sample No.	Test No.	Depth	Tested By	Test Date	Checked By	Check Date	Test File
○	---	1.1	25.8-26.0	jm	12/10/09	mm		1516-1.1.dat
△	---	1.2	26.4-27.0	jm	12/10/09	mm		1516-1.2.dat
□	---	1.3	28.4-29.0	jm	12/9/09	mm		1516-1.3.dat

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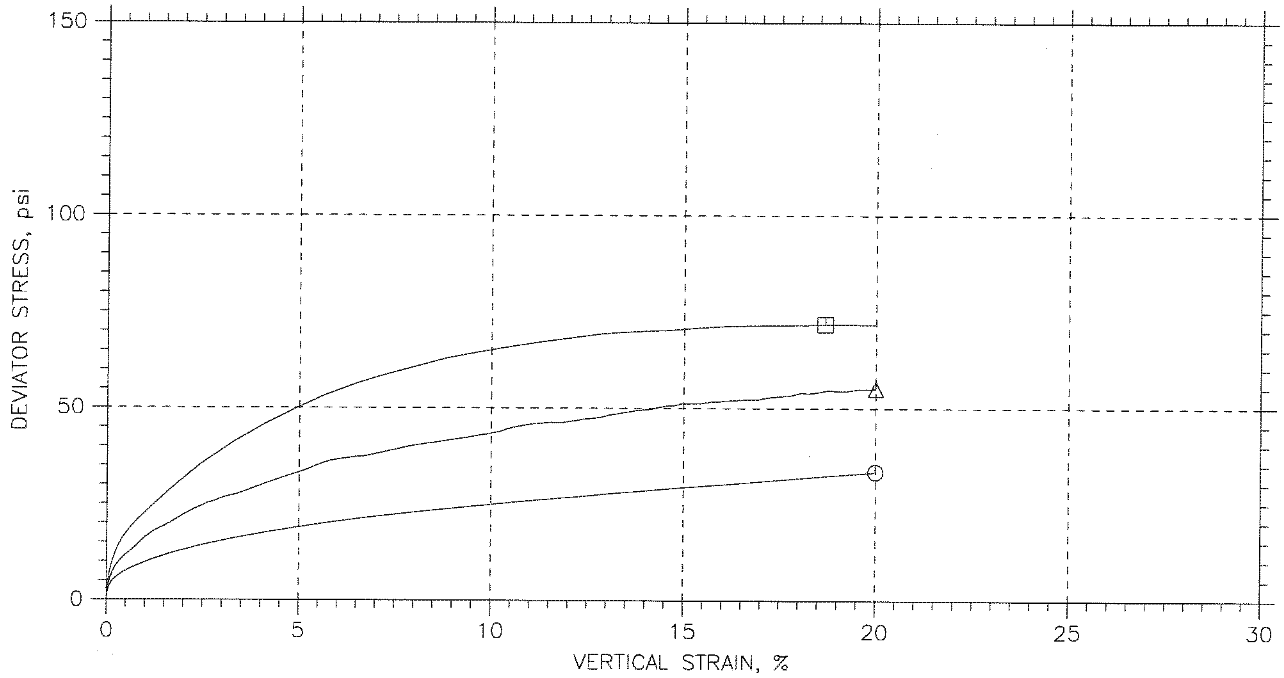
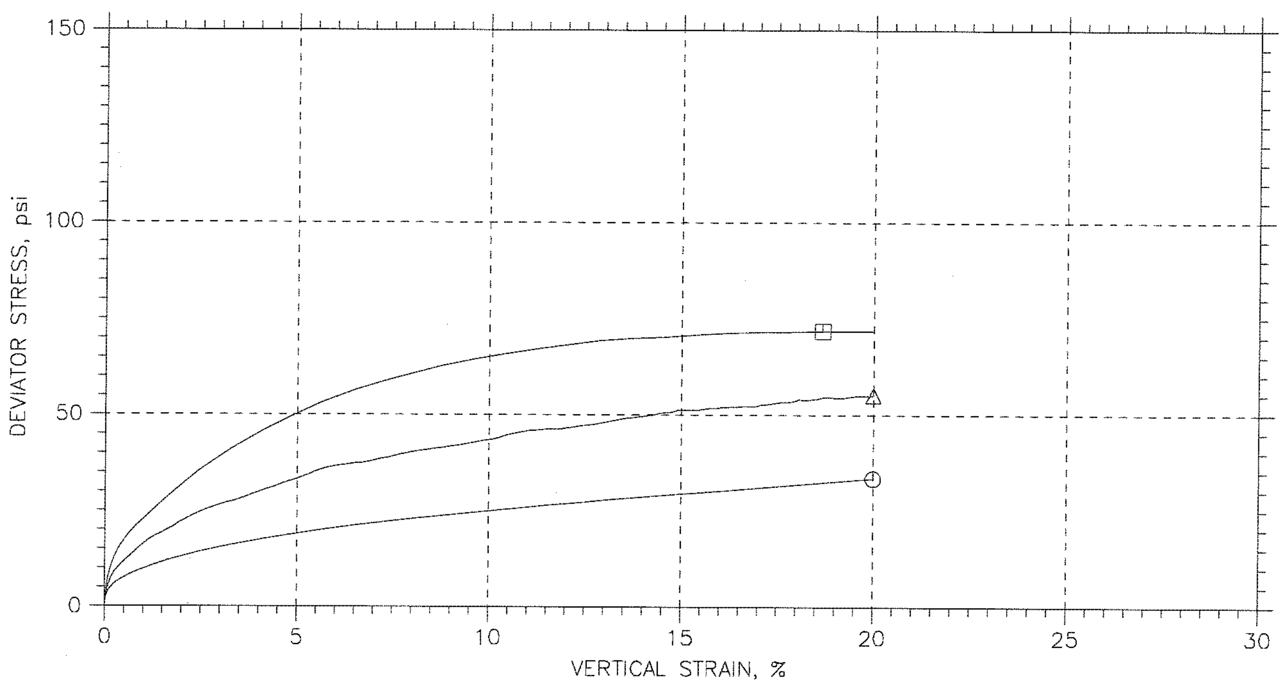
Project: Clifty Creek	Location: Jefferson, IN	Project No.: GTX-1516
Boring No.: B-7	Sample Type: UD	
Description: Light Brown		
Remarks: System 1062		

Mon, 18-JAN-2010 16:57:17

CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767





	Sample No.	Test No.	Depth	Tested By	Test Date	Checked By	Check Date	Test File
○	---	1.1	25.8-26.0	jm	12/10/09	mm		1516-1.1.dat
△	---	1.2	26.4-27.0	jm	12/10/09	mm		1516-1.2.dat
□	---	1.3	28.4-29.0	jm	12/9/09	mm		1516-1.3.dat

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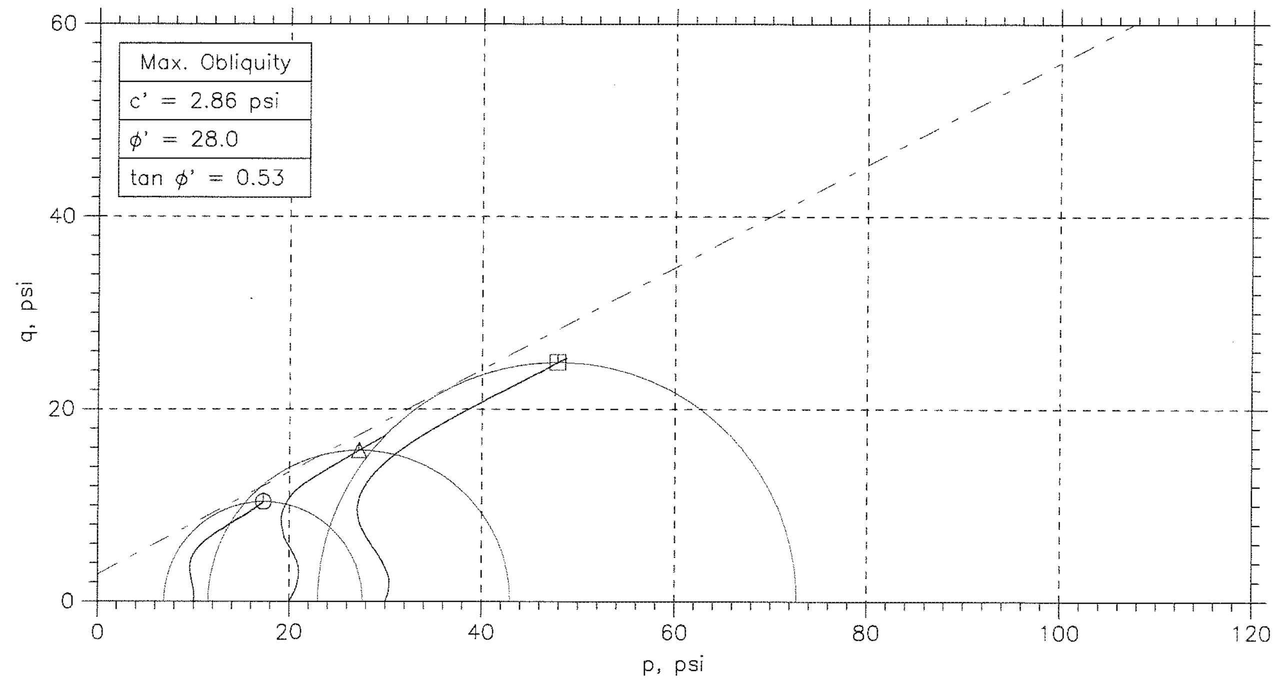
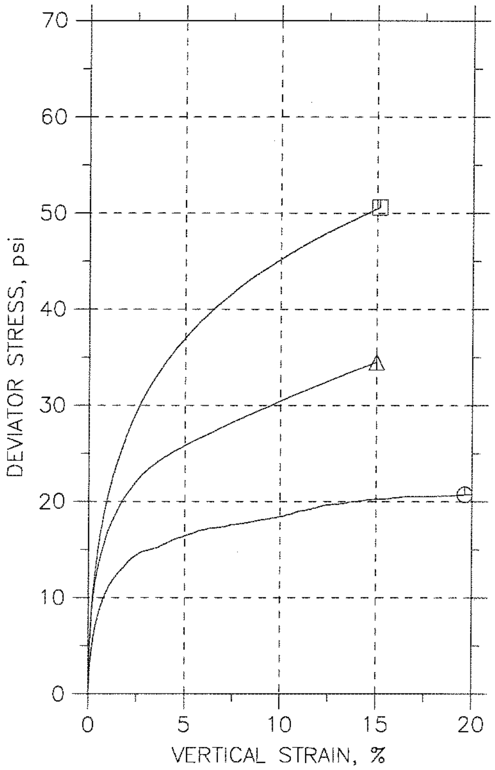
Project: Clifty Creek	Location: Jefferson, IN	Project No.: GTX-1516
Boring No.: B-7	Sample Type: UD	
Description: Light Brown		
Remarks: System 1062		

Mon, 18-JAN-2010 16:57:18

CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767





	Symbol	○	△	□	
	Sample No.	---	---	---	
	Test No.	2.1	2.2	2.3	
	Depth	25.8-26.4	28.4-29.0	30.3-30.9'	
Initial	Diameter, in	2.82	2.824	2.838	
	Height, in	5.82	6.027	6.001	
	Water Content, %	21.0	20.7	20.9	
	Dry Density, pcf	107.2	107.6	107.6	
	Saturation, %	99.2	98.7	99.6	
	Void Ratio	0.572	0.567	0.567	
Before Shear	Water Content, %	20.5	19.8	19.0	
	Dry Density, pcf	108.5	109.8	111.4	
	Saturation*, %	100.0	100.0	100.0	
	Void Ratio	0.554	0.535	0.513	
	Back Press., psi	59.25	124.8	56.31	
	Ver. Eff. Cons. Stress, psi	9.968	19.98	29.96	
	Shear Strength, psi	10.37	17.25	25.3	
	Strain at Failure, %	19.6	15	15.2	
	Strain Rate, %/min	0.016	0.016	0.016	
	B-Value	0.95	0.96	0.95	
	Estimated Specific Gravity	2.7	2.7	2.7	
	Liquid Limit	---	---	---	
	Plastic Limit	---	---	---	

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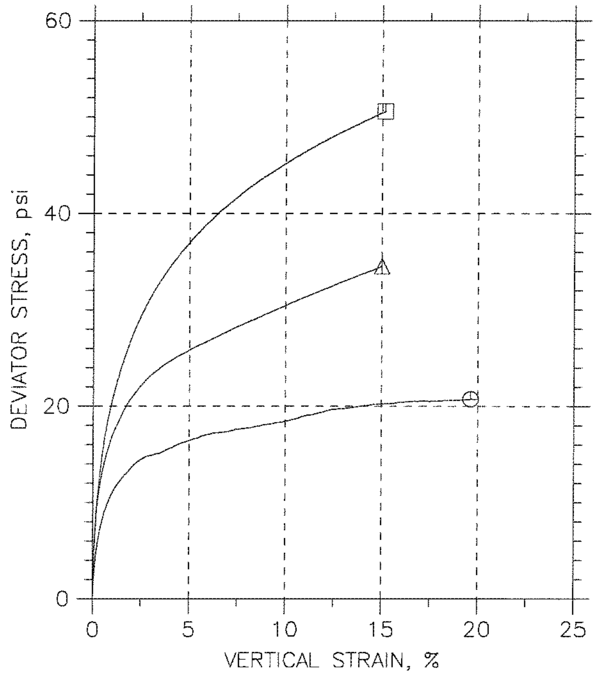
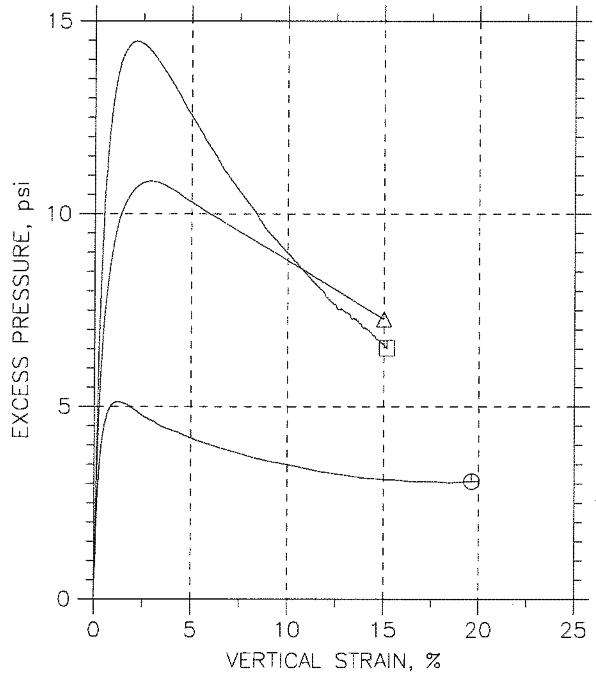
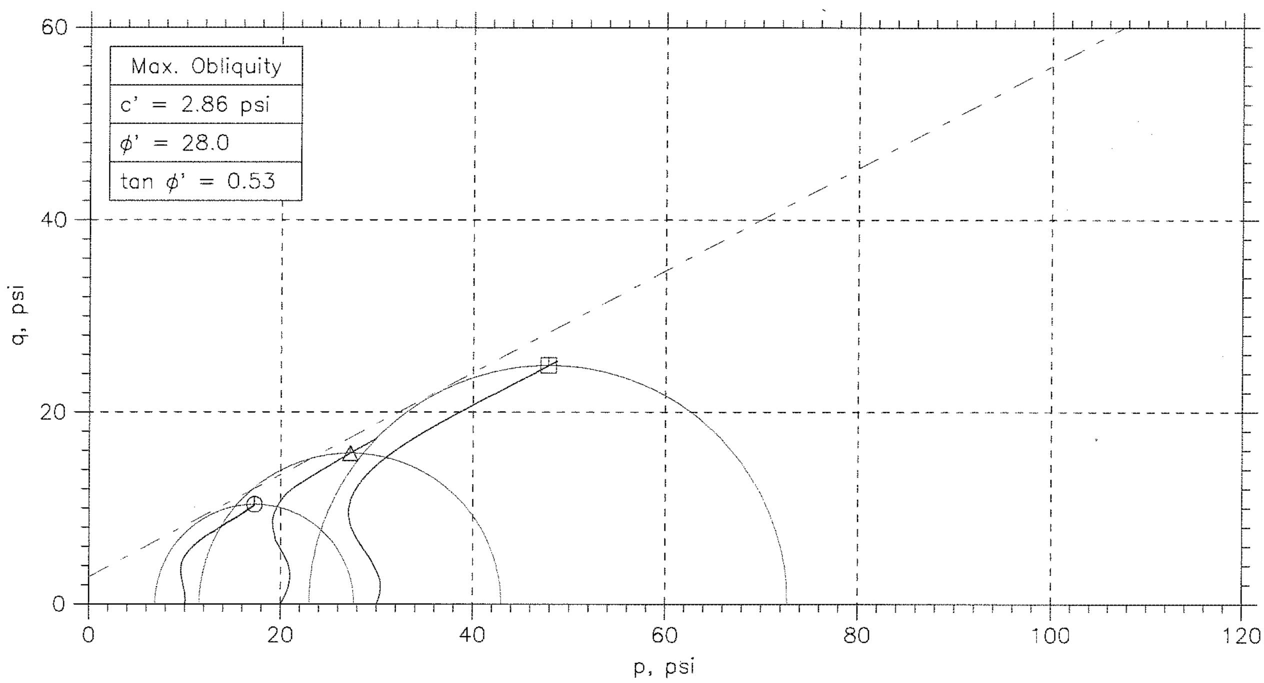
Project: Clifty Creek
Location: Jefferson, IN.
Project No.: GTX-1516
Boring No.: B-8
Sample Type: UD
Description: Greenish brown lean clay with sand
Remarks: 2054

Tue, 19-JAN-2010 09:45:51

CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767







	Sample No.	Test No.	Depth	Tested By	Test Date	Checked By	Check Date	Test File
○	---	2.1	25.8-26.4	jm	12/11/09	mm		1516-2.1.dat
△	---	2.2	28.4-29.0	jm	12/11/09	mm		1516-2.2A.dat
□	---	2.3	30.3-30.9'	jm	12/09/09	mm		1516-2.3.dat

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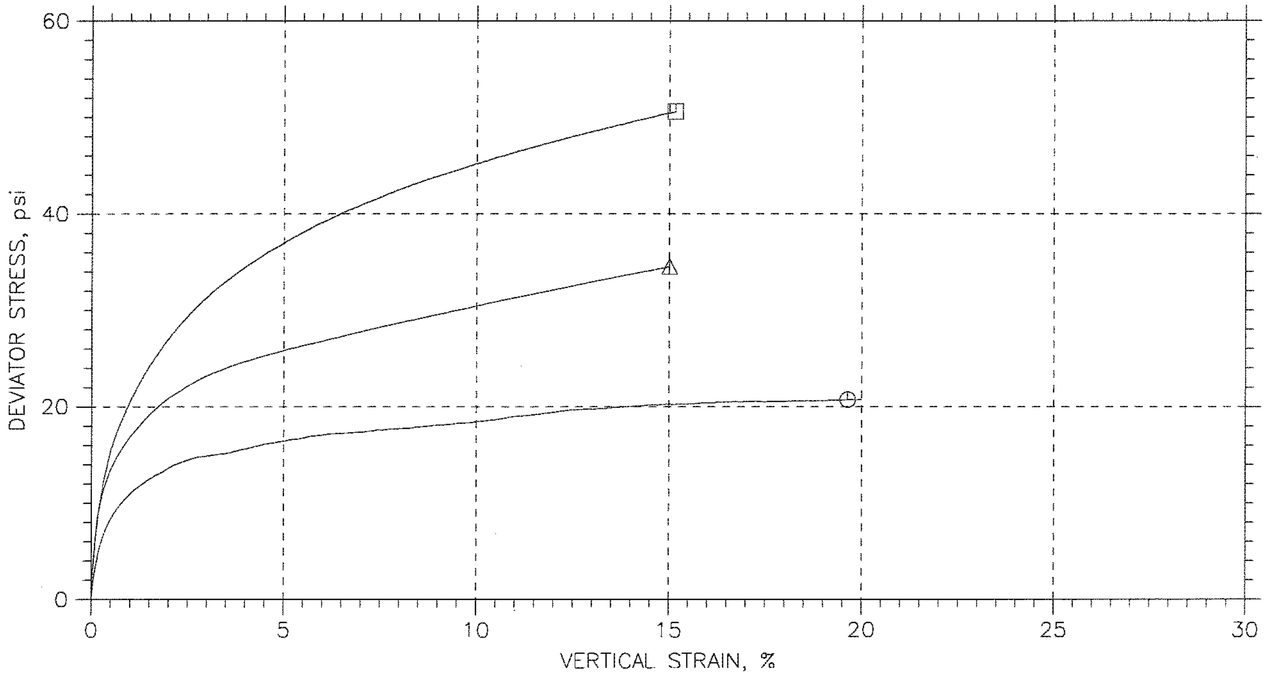
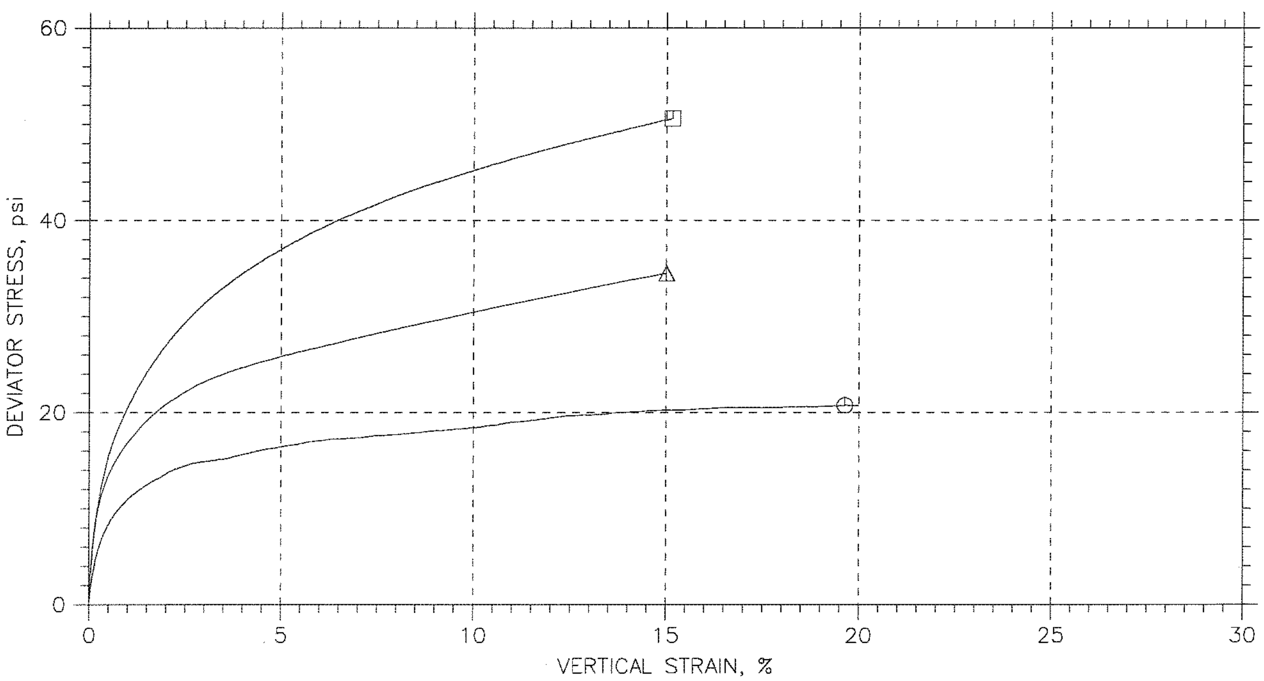
Project: Clifty Creek	Location: Jefferson, IN.	Project No.: GTX-1516
Boring No.: B-8	Sample Type: UD	
Description: Greenish brown lean clay with sand		
Remarks: 2054		

Tue, 19-JAN-2010 09:45:53

CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767





	Sample No.	Test No.	Depth	Tested By	Test Date	Checked By	Check Date	Test File
○	---	2.1	25.8-26.4	jm	12/11/09	mm		1516-2.1.dat
△	---	2.2	28.4-29.0	jm	12/11/09	mm		1516-2.2A.dat
□	---	2.3	30.3-30.9'	jm	12/09/09	mm		1516-2.3.dat

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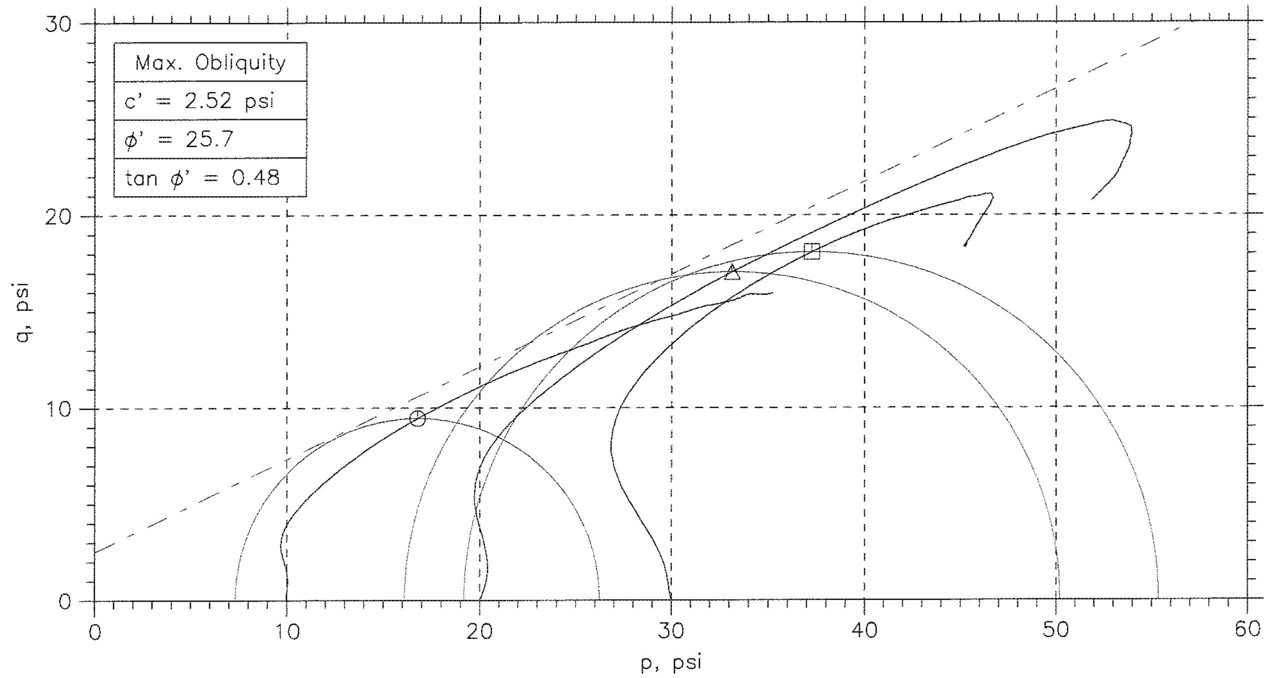
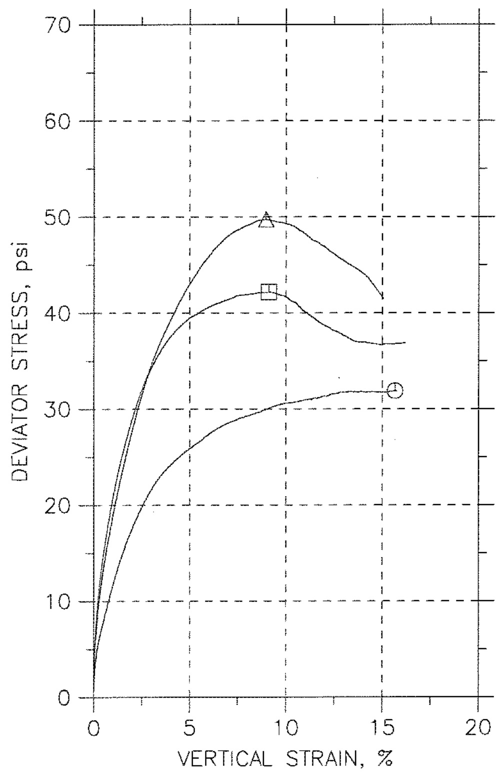
	Project: Clifty Creek	Location: Jefferson, IN.	Project No.: GTX-1516
	Boring No.: B-8	Sample Type: UD	
	Description: Greenish brown lean clay with sand		
	Remarks: 2054		

Tue, 19-JAN-2010 09:45:54

CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767





Symbol	⊙	△	⊡	
Sample No.	---	---	---	
Test No.	3.1	3.2	3.3	
Depth	17.4-18.0	19.4-20.0	20.8--21.4	
Initial: Diameter, in	2.835	2.835	2.837	
Initial: Height, in	6.319	6.281	6.177	
Initial: Water Content, %	19.4	18.4	20.8	
Initial: Dry Density, pcf	109.7	111.4	107.3	
Initial: Saturation, %	97.8	96.9	98.6	
Initial: Void Ratio	0.536	0.514	0.571	
Before Shear: Water Content, %	19.2	18.9	22.7	
Before Shear: Dry Density, pcf	111.	111.7	104.5	
Before Shear: Saturation*, %	100.0	100.0	100.0	
Before Shear: Void Ratio	0.518	0.509	0.613	
Before Shear: Back Press., psi	136.8	122	116.2	
Ver. Eff. Cons. Stress, psi	9.997	19.96	29.88	
Shear Strength, psi	15.94	24.86	21.08	
Strain at Failure, %	15.7	8.98	9.12	
Strain Rate, %/min	0.016	0.016	0.016	
B-Value	0.95	0.96	0.95	
Estimated Specific Gravity	2.7	2.7	2.7	
Liquid Limit	---	---	---	
Plastic Limit	---	---	---	

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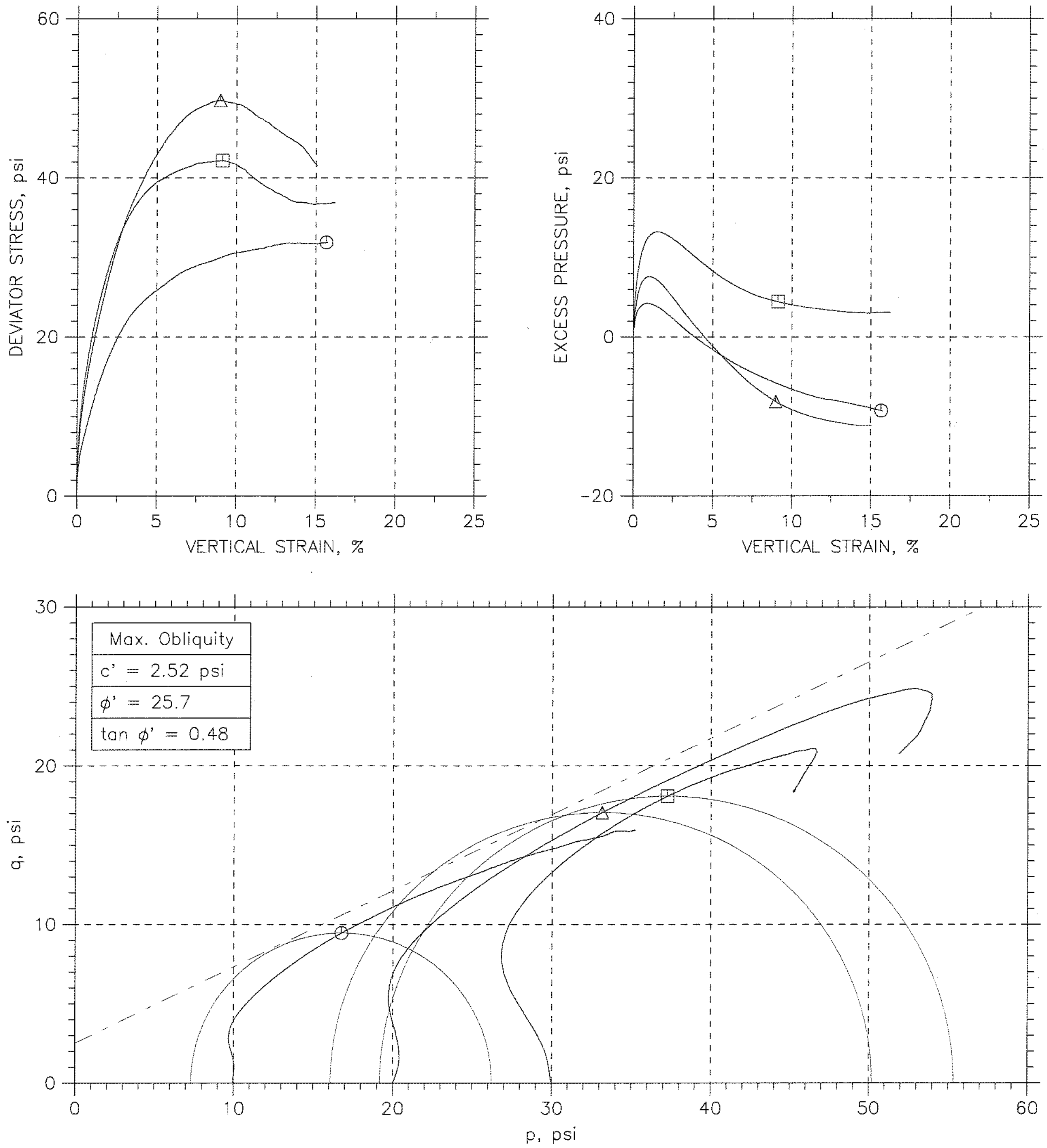
Project: Clifty Creek	
Location: Jefferson, IN	
Project No.: GTX-1516	
Boring No.: B-9	
Sample Type: UD	
Description: Brown lean clay with sand	
Remarks: System 1057	

Tue, 19-JAN-2010 10:34:11

CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767



	Sample No.	Test No.	Depth	Tested By	Test Date	Checked By	Check Date	Test File
⊙	---	3.1	17.4-18.0	jm	12/15/09	mm		1516-3.1.dat
△	---	3.2	19.4-20.0	jm	12/16/09	mm		1516-3.2Adat.dat
⊞	---	3.3	20.8--21.4	jm	12/10/09	mm		1516-3.3.dat

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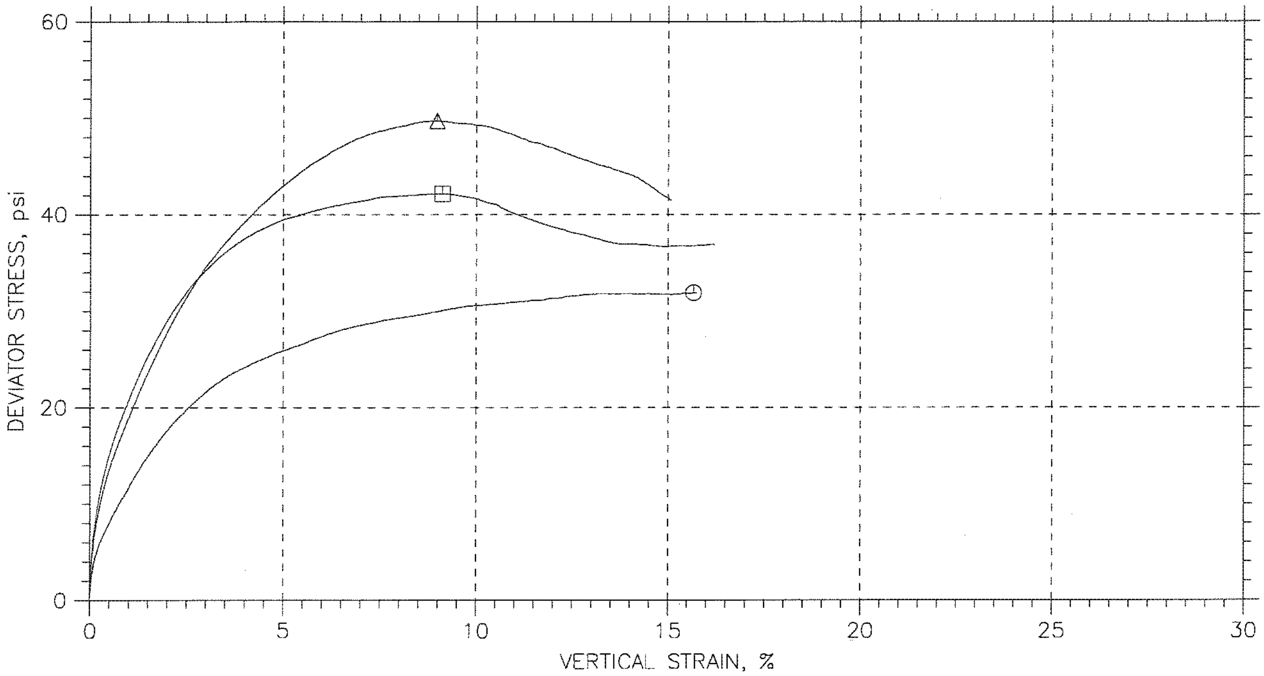
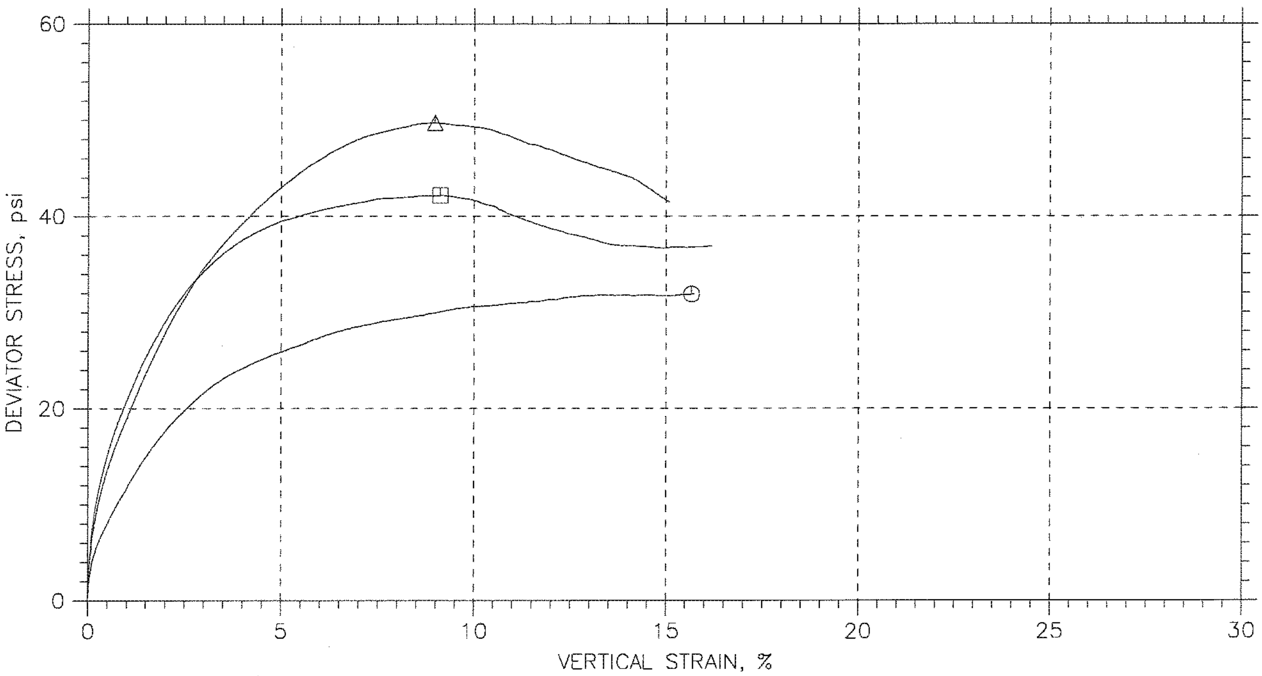
Project: Clifty Creek	Location: Jefferson, IN	Project No.: GTX-1516
Boring No.: B-9	Sample Type: UD	
Description: Brown lean clay with sand		
Remarks: System 1057		

Tue, 19-JAN-2010 10:34:12

CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767





	Sample No.	Test No.	Depth	Tested By	Test Date	Checked By	Check Date	Test File
○	---	3.1	17.4-18.0	jm	12/15/09	mm		1516-3.1.dat
△	---	3.2	19.4-20.0	jm	12/16/09	mm		1516-3.2Adat.dat
□	---	3.3	20.8--21.4	jm	12/10/09	mm		1516-3.3.dat

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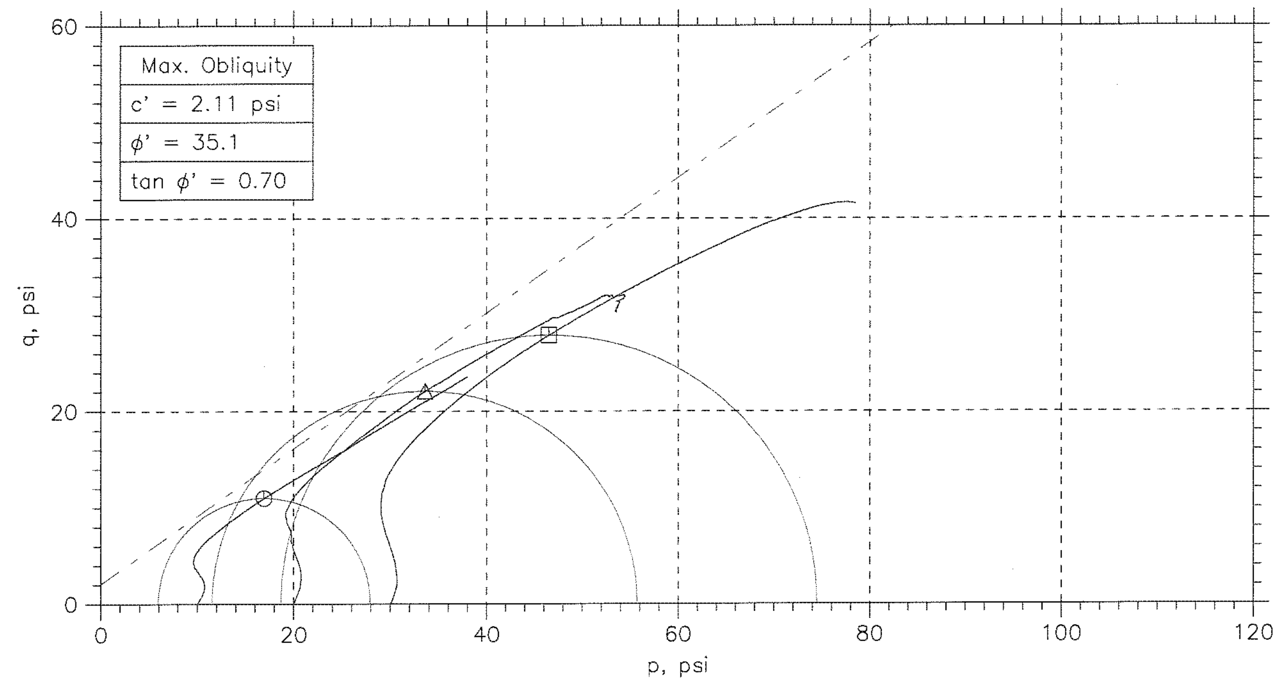
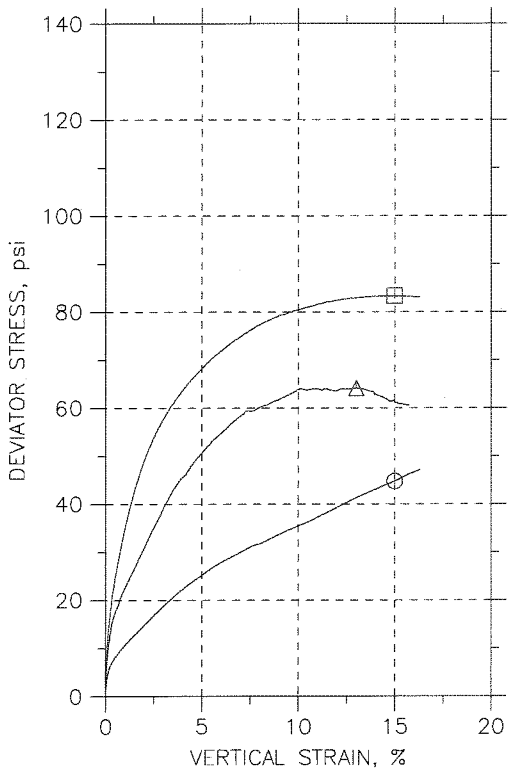
Project: Clifty Creek	Location: Jefferson, IN	Project No.: GTX-1516
Boring No.: B-9	Sample Type: UD	
Description: Brown lean clay with sand		
Remarks: System 1057		

Tue, 19-JAN-2010 10:34:14

CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767





Symbol		○	△	□	
Sample No.		---	----	----	
Test No.		CU-4.1	CU-4.2	CU-4.3	
Depth		13.4-14.0'	16.8-17.4'	17.4-18.'	
Initial	Diameter, in	2.83	2.71	2.72	
	Height, in	5.78	5.52	5.51	
	Water Content, %	14.2	27.4	26.6	
	Dry Density, pcf	102.9	93.8	93.72	
	Saturation, %	59.9	93.0	89.9	
	Void Ratio	0.638	0.797	0.798	
Before Shear	Water Content, %	23.2	18.5	19.2	
	Dry Density, pcf	103.7	112.4	111.	
	Saturation*, %	100.0	100.0	100.0	
	Void Ratio	0.625	0.5	0.519	
	Back Press., psi	27.99	73	84.99	
Ver. Eff. Cons. Stress, psi		10	19.99	30	
Shear Strength, psi		22.37	32.06	41.66	
Strain at Failure, %		15	13	15	
Strain Rate, %/min		0.032	0.032	0.032	
B-Value		0.95	0.95	0.96	
Estimated Specific Gravity		2.7	2.7	2.7	
Liquid Limit		---	---	---	
Plastic Limit		---	---	---	

GeoTesting express a subsidiary of Geocomp Corporation	Project: Clifty Creek
	Location: ----
	Project No.: GTX-1516
	Boring No.: B-10
	Sample Type: UD
	Description:
	Remarks: 2054

Tue, 19-JAN-2010 11:56:28

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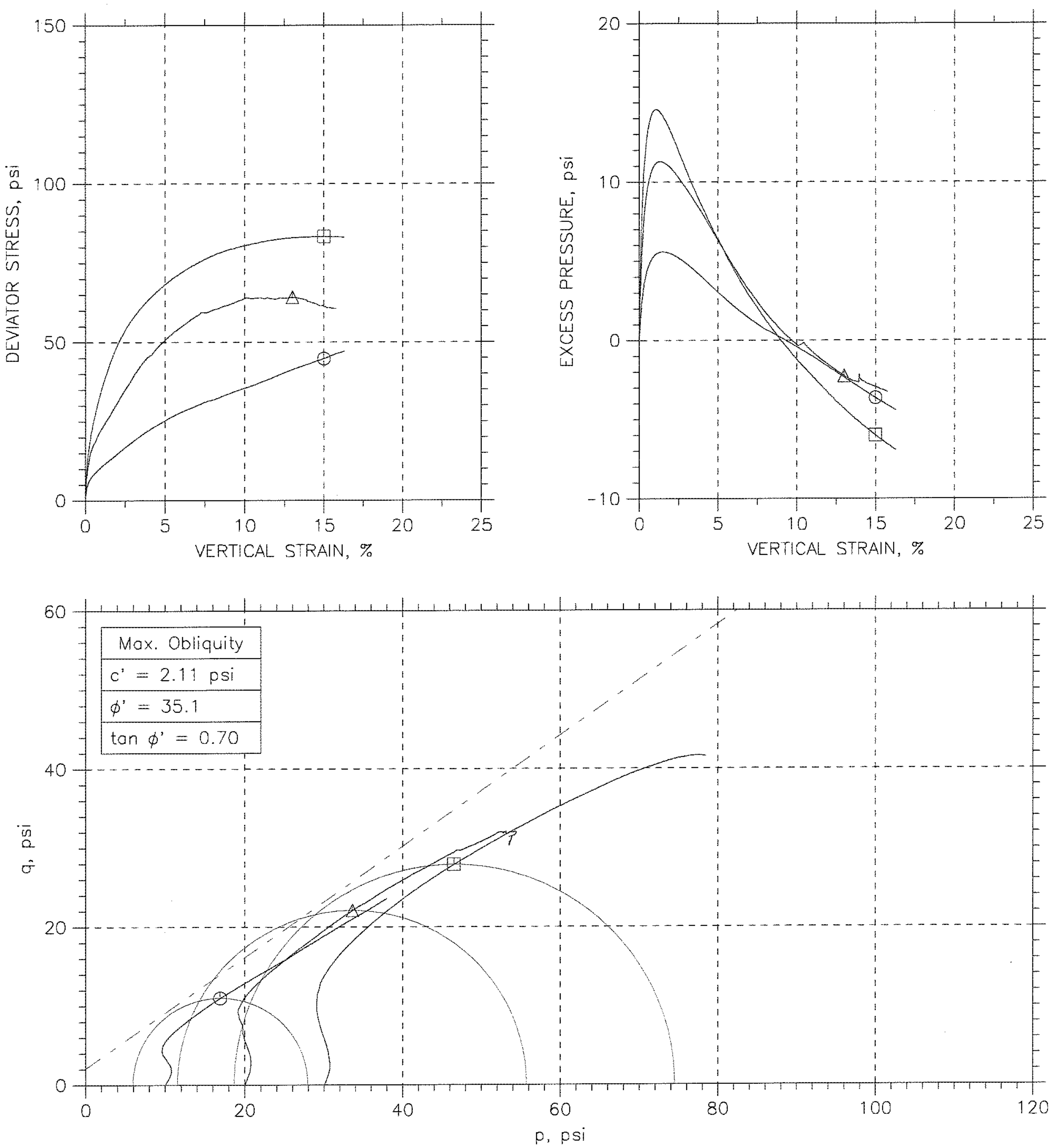
CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767



	Sample No.	Test No.	Depth	Tested By	Test Date	Checked By	Check Date	Test File
○	---	CU-4.1	13.4-14.0'	JM	12/12/09	MM		1516-4.1.dat
△	----	CU-4.2	16.8-17.4'	JM	12/13/09	MM		1516-4.2.dat
□	----	CU-4.3	17.4-18.'	JM	12/12/09	MM		1516-4.3.dat

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Project: Clifty Creek	Location: ----	Project No.: GTX-1516
Boring No.: B-10	Sample Type: UD	
Description:		
Remarks: 2054		

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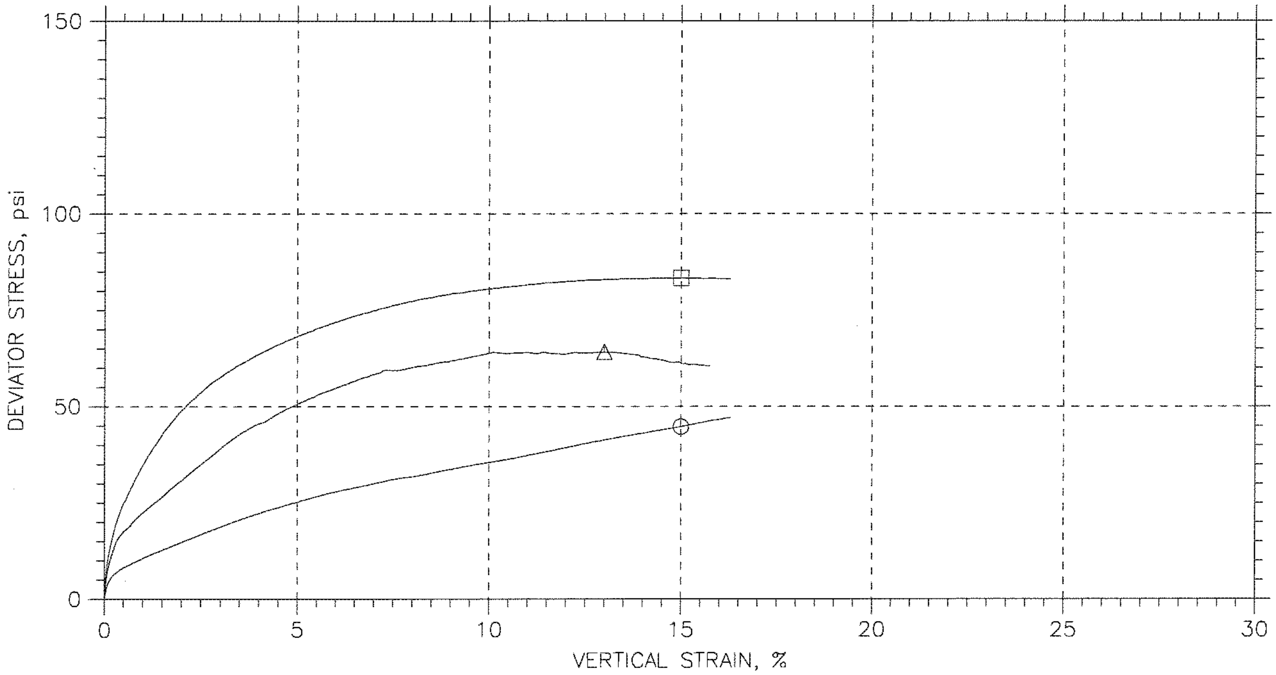
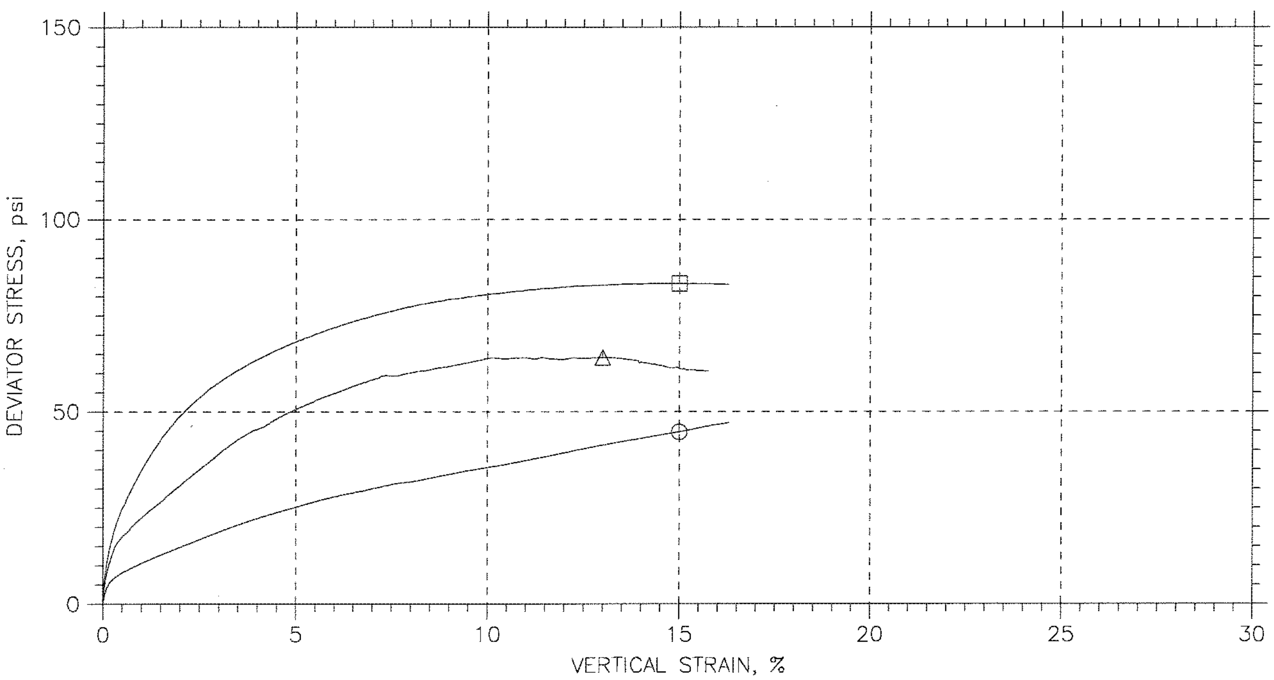
CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767





	Sample No.	Test No.	Depth	Tested By	Test Date	Checked By	Check Date	Test File
○	---	CU-4.1	13.4-14.0'	JM	12/12/09	MM		1516-4.1.dat
△	----	CU-4.2	16.8-17.4'	JM	12/13/09	MM		1516-4.2.dat
□	----	CU-4.3	17.4-18.'	JM	12/12/09	MM		1516-4.3.dat

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Project: Clifty Creek	Location: ----	Project No.: GTX-1516
Boring No.: B-10	Sample Type: UD	
Description:		
Remarks: 2054		

Tue, 19-JAN-2010 11:56:31

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